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THE THERMAL BATHS OF THE VALE OF LAMALOU.

THE commune of Lamalon-les-Bains is situated in the department of Herault, France. It consists of three thermal establishments, designated as Lamalon-le-Bas, Lamalou-le-Centre and Lamalou-le-Haut.

The origin of these establishments is far from dating from the same epoch. Lamalon-le-Bas justly prides itself upon having founded the reputation of the Thermal Vale, and upon having given it its name. So it clings tenaciously to its denomination of Lamalon-l'Ancien. A few historic facts easily establish its right to this appellation.

According to tradition, the peasants of the vicinity were accustomed from time immemorial to visit this locality and plunge into a sort of mud puddle fed by the ancient spring in order to assuage their pains and aches. In the local dialect, Malon signifies "pain," hence the etymology of the name, which is an abbreviation of laux de la Malon, that is "pain waters."

In 1794, Viscount de Thezan, the owner of the spring, constructed some swimming baths, which were as well appointed as the habits of the epoch required. The reputation of these primitive thermal baths soon extended into the neighboring provinces, and the physicians of Montpellier sent the other numerous patients. It is from this time that dates the true renown of Lamalou. As the reputation of the baths kept ever increasing, the owners were obliged to make successive repairs and improvements. This work has made of Lamalou-l'Ancien a very extensive establishment.

The neighboring land owners soon undertook work of the same nature, and it is thus that relatively recent borings have given rise successively to the baths of Lamalou-le-Haut and Lamalou-le-Centre.

These three establishments are quite close to each other and are connected by an avenue about one and a quarter miles in length, shaded with plane trees and constituting one of the favorite promenades of the bathers.

GRAND HOTEL DES BAINS, LAMALOU.

Lamalou-le-Bas.—The establishment of Lamalon-le-Bas or l'Ancien is situated at the foot of a hillock called Usclade, which forms the western limit of the vale. It represents the back of a parallelogram, which is open at the opposite extremity, and the sides of which are formed by the hotel of the establishment.

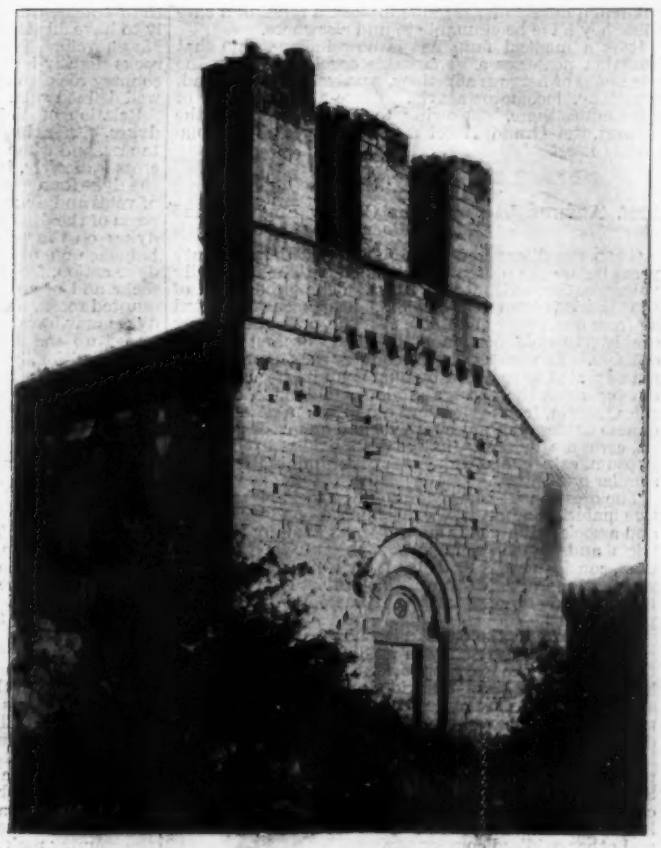
The balneary establishment is divided into two distinct parts, each of which is again divided into two parts, one for each sex. Taking as a type the part designed for men, we find vast warming rooms surrounded by numerous dressing rooms, and each doing duty for several swimming baths, bath tubs, foot baths, etc.

The establishment also possesses another means of thermal medication—the vaporarium or vapor bath, which is formed by the subterranean gallery of the springs of the Usclade. The remarkable thing about this vaporarium is the number, richness, and temperature of the jets of mineral water that emerge from it. There are over a dozen of these, and some of them have a temperature of no less than 90° C.

The happy arrangement of this gallery, the elevation of temperature occasioned by the emerging of the thermal water, and the disengagement of carbonic acid that occurs, make it the most natural and salutary of vapor baths.

The water of the ancient spring directly supplies the swimming baths and bath tubs, and the water of the new springs is led into well-cemented reservoirs, in which it is impossible for it to lose its caloric. From these

PONT DU DIABLE, OLD ROMAN BRIDGE, LAMALOU.



CHURCH OF ST. PIERRE DE RHEDES (ELEVENTH CENTURY).

reservoirs the water is led directly to the bath rooms and shower baths, and to the large swimming baths.

Of the two springs, the ancient is by much the more important, and it alone supplies that part of the thermal establishment in which the swimming baths are located. The water is perfectly limpid and constantly disengages carbonic acid. It has no odor, and its taste, which is slightly acid, is somewhat bitter and styptic. The impression that one experiences in plunging into the swimming baths of Lamalou-l'-Ancien consists in a feeling of general comfort, which increases in measure as the bath is prolonged. At the first plunge there is generally felt a slight tingling of the skin, which soon gives way to a sensation such as would be produced by contact with a slightly unctuous body, and which persists for some time after one's exit from the bath. The temperature of the ancient spring is 34·2°, and is constant at all epochs of the year.

The other spring, called the Stoline, gushes at a few yards from the preceding, and flows into the court of the establishment. It is this spring (which is very important as regards its discharge) that permits of obtaining temperate baths of 30°. This spring serves as a drinking fountain to the establishment.

Lamalou-le-Centre.—This establishment is situated in the center of the vale at the back of a charming garden that skirts the central avenue.

The balneary establishment, which is of modern construction, comprises numerous bath rooms on the ground floor and first story and several hydrotherapic halls. The bath rooms are supplied by mineral water at the natural temperature, and by superheated water. The establishment is surrounded with numerous drinking fountains.

Lamalou-le-Haut.—This establishment is situated at the extremity of the thermal vale, at the part most distant from the railway station. The balneotherapic installation comprises for each sex: A reserved swimming bath of red marble; a cold swimming bath; a common swimming bath; and two small family swimming baths.

The different swimming baths are preceded by quite comfortably arranged warming rooms. A shower bath room permits of associating this mode of treatment with the baths, which form the essential part of it, but the installation is inadequate for the practice of hydrotherapy, properly so called.

The Drinking Fountains.—Numerous drinking fountains contribute toward forming the truly exceptional hydromineral wealth of the vale of Lamalou. These, following the order adopted for the establishments, are called: La Verniere, L'Usclade, La Stoline, Cardinal Spring, Capus Spring, Bourges Spring, New Spring, Little Vichy, and Moise and Mine Spring.

Medicinal Properties of the Waters of Lamalou.—It is through their salutary effects in rheumatismal affections that the waters of Lamalou have established their ancient reputation; and rheumatism in all its manifestations, and principally nervous, sciatic and visceral rheumatism, brings to these thermal baths a large contingent of patients.

But there is a series of affections which the conditions of life, the struggle for existence and the fever and the agitation of the age seem to have rendered particularly frequent at our epoch, and which concur in establishing the reputation of the waters of Lamalou. These are the affections of the nervous system, and especially diseases of the spinal marrow, and, more especially, among such diseases, tabes or locomotor ataxia. Now, thanks to the observations of the celebrated Charcot, of his pupils of the Salpetriere, of the professors of the school of Montpellier, and of Dr. Belugon, one of the physicians of the Continent who is best acquainted with diseases of this nature, and who is practising at Lamalou during the season, which is from April 1 to November 1, and thanks also to the extraordinarily successful practice of the most renowned physicians of Europe, the baths of Lamalou are yearly the abode of a host of neurotics, who come from all quarters of the globe to seek a relief or a cure that they have been unable to find elsewhere.

It is a medical fact that is now indisputable that Lamalou possesses a remarkable specialization in the treatment of nervous affections, paralysis, atrophy, and, especially, locomotor ataxia. There are a number of good hotels there, but, owing to its convenience to the springs, the Grand Hotel des Bains specially recommends itself.

CRIPPLE CREEK.

Prof. Arthur Lakes, in the Colliery Engineer and Metal Miner.

Gold was discovered in Cripple Creek about twenty years before the present developments. The first really valuable discoveries were in 1891. The production of the district, from 1891 to 1894, has been estimated at from five to seven millions. The ores are almost exclusively gold ores; a little silver occurs in most of them. The ore consists of country rock more or less impregnated or replaced by quartz and other minerals, among which the most abundant are fluorite, opaline, silica, kaolin, iron pyrites and other iron minerals, manganese oxides, and more rarely small quantities of galena, cerussite, anglesite, native gold, oxidized tellurium, gypsum, calcite, and numerous other minerals in still smaller quantities.

The ores consist simply of country rock, either eruptive materials or granite, containing secondary quartz and associated minerals instead of, as in many gold districts and, in fact, as in parts of the Cripple Creek district, consisting of well defined bodies of these materials. A characteristic ore of this district is an intimately mixed mass of quartz and fluorite of a brilliant purple color.

Gold occurs in the ore as native or free gold, as telluride of gold, and possibly as gold-bearing iron pyrites, the last being the least important form. It has been largely derived from telluride by oxidation, though some may have been derived from gold-bearing iron pyrites, or may have been in the free state since it was deposited. Most of the gold at a depth is in the form of telluride called calaverite, locally called sylvanite. Iron pyrites is abundant, but rarely carries much gold. Surface alterations have oxidized, hydrated and leached certain minerals in the ore deposits, as well as forming sulphates, phosphates, hydrous silicates, tellurides and other oxidized compounds.

The value of the ores varies at present from $20 to $400 per ton, though small shipments run up several thousands of dollars per ton. The district is a shipper of high grade ores, and with increased facilities for treatment, the large quantities of lower grade ores that occur can be used and the production increased.

The gold, both in vein and placer deposit, is derived from the decay and erosion of the ore bodies and of the country rock. The gold placers have produced a considerable quantity of gold, but the veins or ore bodies in place are far more important. These generally occur in fissures in the country rock, which usually represent slight faulting. The veins intersect all rock in their course, and have been formed mostly of a replacement along the fissures, and not, except to a very small extent, by filling of open gaps.

The existence of numerous dykes in the region indicates the presence of pre-existing fissures, so that fissuring action undoubtedly began some time before the formation of dykes. In fact, it is natural to suppose that such action occurred during the whole of the eruptive epoch of the district. In some places the veins occupy these early fissures, but in a general way the vein fissures do not seem to have been the earliest ones formed, though many of them were produced before the dyke action ceased. In most cases the fissures occupied by veins were formed after the intrusion of the dykes, as shown by the fact that they intersect the latter.

The fissuring action affected both the volcanic area and surrounding granite, so that the whole region is much broken by numerous fissures intersecting one another at various angles. In any single locality one general course is usually prominent, though intersecting fissures of less prominence are always present, and in some places there are two or more systems of parallel fissuring. The general course of the fissures carrying the veins of the district, like that of the dykes, varies from northeast to northwest; often it is nearly due north and south. Some fissures strike more nearly east and west, but in most of the important veins a more northerly trend is distinctly characteristic.

The fissures are usually represented by one main fracture, with numerous subordinate parallel or approximately parallel fractures, though sometimes two or more fractures occur close together. Frequently there is no one specially well defined break, but a number of closely parallel fissures of about equal size, giving the rock a minutely banded or sheeted structure and forming a fissured zone. The character of the fissures is much affected by the nature of the rocks they intersect, for they are sharper and better defined in the hard or brittle rocks than in the softer and more plastic ones.

These fissures are usually the result of movement, probably accompanied by a certain amount of faulting, as is proved by the occasional occurrence of fragments of rock in the better defined fissures and the abundance of grooves or slickensides on their face. Evidence so far obtained indicates that the faults in the vein fissures have throws varying from a fraction of an inch to several feet. Outside of the immediate Cripple Creek district, however, faults occur with a displacement of over 1,000 ft. Faulting may have been the cause of the occurrence of the granite breccia between the granite rim and central area of volcanic breccia. This material forms a belt from a few feet to several hundred feet in width, and is seen at many places where the central zone of the granite and the volcanic breccia is visible; its character and mode of occurrence make it evident that it is due to volcanic action and not to faulting, though the material itself is more or less broken by later faults.

The veins are simply bodies of secondary minerals filling the fissures. Sometimes the veins are single, well defined bodies of ores; sometimes they are parallel seams filling the fissured zones. They occur in all the rocks, in breccia, massive eruptive, and granite. The veins are largely a replacement of the country rock along very narrow fissures, which were hardly more than cracks, though occasionally the ore appears locally to have filled small open places among them, as in the Moose vein. Every gradation occurs, from country rocks slightly impregnated with ore along a fissure, to country rock completely replaced and converted to a well defined vein.

Relation of Veins to Dykes.—The veins often follow dykes, either throughout their courses or for short distances, and when a vein meets a dyke, though it may cross it directly, it is likely to be deflected and to follow the dyke for a greater or less distance. This association of veins and dykes is a prominent feature of certain parts of the district attributable to the influence of the dykes on the vein fissures, and in less degree to their influence on ore deposition. Ore deposition followed dyke action, for it depended on the presence of heated rocks and occurred more in the direction of the latest erupted rocks, namely, the dykes, than elsewhere. The dykes may have cut water channels, and the water thus forced up the sides of the dykes might have caused ore deposition, hence the connection between dykes and veins. The dykes directed the course of the latest fissures in which many of the veins were deposited.

Changes in Veins and Dykes with Depth.—Near the surface veins and dykes dip at angles, while sometimes veins occur in one well defined fissure at a depth, fork near the surface, appearing in two or more separate outcrops. This is due to the district being comparatively young geologically, and erosion has not yet completely obliterated the original character of the upper part of the formations. The fissures occupied by the dykes or veins were confined to the original line of breakage at a depth, on account of the overlying pressure, while nearer the surface this pressure was relieved, numerous cross fractures of a superficial character were encountered, and the fissures more easily deflected or divided.

Later Movements in the Veins.—After or during the filling of the fissures with ore, movements in some places occurred along them, since in some mineral veins the mineral contents are cut by longitudinal breaks, as in the Raven and Elkton mines. A similar movement took place along the minor fractures that cross many of the veins, for the latter are cut by indistinct cross cracks.

Sometimes cracks or sheeted zones occur in dykes at their contact with the country rock and follow all the curves in the meanderings of the dykes. The sheeted structure is caused by shrinkage of the dykes along the country rock during cooling. These cracks are not so deep seated or far reaching as the fissures caused by later disturbances, and, therefore, when unaffected by these fissures, they have rarely become repositories of ore bodies.

Since the time of the ore disposition, erosion has occurred in Cripple Creek, and veins have been worn down as well as country rock. The gold in their eroded parts, by virtue of greater specific gravity, has been concentrated with the gravels in gulches and low places, forming placers. Country rock, also, outside of veins, contains some gold and has added to the placer deposits. The placers north and west of the town occupy hollows in amphitheaters of hills surrounding the headwaters of Cripple Creek. Placers have been worked by pan, rocker and sluice, and by dry washers. The water available for wet processes is limited, and so no attempts have been made at hydraulic mining.

The precious metals have been derived from the volcanic rock and adjacent granite, not exclusively from shallow sources or immediately adjacent rocks, but from the whole area of rocks in which the underground drainage was tributary to the fissure at the line of the ore deposition. The concentration of the gold in fissures was by hot, solvent solutions, under pressure, dissolving the metal and carrying it into fissures. The richest veins occur in eruptive rocks or granite near vents from which the eruptions were ejected, and became poorer with distance from them, because this supplied the hot solutions necessary for dissolving ore and depositing it.

Other vein materials accompanying the gold came from similar sources. Fluorine in the fluorite, common in the district, came into the fissures as a volatile or in a soluble form, as by hydrofluoric acid, or hydrofluoric silicates, or soluble fluorides, and there encountered solutions, which carried carbonate of lime derived from decay or eruptive rocks, or from other sources producing fluoride or calcium or fluorite accompanied by a deposition of silica or quartz, hence the intimately associated mixture of quartz and fluorite known as "purple" quartz characteristic of the district.

Ore Shoots.—The gold is not uniformly distributed throughout the fissures, but concentrated in certain parts into bodies of ore of varying shape, size and continuity known as ore shoots. These trend variously in the fissures, though often a general southerly pitch down and along the fissure is common, especially where the course of the shoot is guided by certain cross fissures. Elsewhere the shoots dip vertically and more rarely a little to the north. They vary from one foot to several hundred feet in width along the fissures and from a few inches to several feet in thickness. In some places they have a well-defined columnar shape, in others their forms are highly irregular. In some they outcrop at the surface; in others their apex is many feet below the surface. Again, sometimes, they extend continuously as deep as they have yet been followed; in others they end at a comparatively shallow depth, though in some cases these shallow shoots may be replaced by others at greater depth.

The localizing of ore in shoots is due to a restricted circulation of ore-bearing solutions guided by the more permeable places along fissures, and by transverse fractures, and to other and minor causes.

This is eminently a prospecting region. So far but few mines have been discovered in it outside of the phonolite dykes in a general way surrounding the Cripple Creek center.

In glancing at the region north and west of the central Cripple Creek mass, we observe a few general and prominent characteristics, viz., a wide general ground mass of granite, and on the west a broad area of volcanic lavas, principally composed of a dark basic breccia, with a few patches of this basic breccia, straggling off from it, mingled or patched with other lavas, principally trachyte and rhyolite.

The other features are a few disconnected, straggling patches of sedimentary strata, principal among which is Woodland Park, in the northeast corner, underlaid by red Jura Trias sandstone, and the long, straggling lake bed formation of Florissant, which looks on the colored map like a tattered oak leaf, dotted over here and there with little red oak galls. These latter are patches of rhyolite and other lavas, relics of former extensive flows. About the middle of the map are sedimentary lake beds of Alnwick and High Park, patched and partly surrounded by rhyolite or volcanic breccia. There is a small patch of the same andesitic breccia as at Cripple Creek in the Bare Hills, but with the exception of one small locality near High Park, those phonolite dykes and patches which congregate so around Cripple Creek and south as far as Nipple Point, are conspicuously absent from this north and western volcanic area. The few sedimentary rocks that occur outside of those we have mentioned are more interesting from a scientific than from a mining point of view. The patches found here and there on High Creek and near the edge of Bare Hills are patches of Cretaceous and Jurassic sediments consisting of sandstones and limestones of fresh water marine origin, showing that Cretaceous water must at one time have covered portions of this area.

From a prospector's point of view the points that will most attract his attention are the patches of volcanic rock, the basic breccias, and the rhyolites, trachytes and andesites. These are the most likely localities next to Cripple Creek and its phonolites for finding ore.

The large volcanic area of basic breccia is composed of fragments of very dark lavas, principally basalt and dark andesites, with occasionally thin local flows and narrow dykes of basalt. The rock, as far as we noticed it in passing through the region, has a dark, rugged, forbidding appearance, like a quantity of black cinders cemented together with black or dark cindery sand. Examples of these basic breccias are seen on Saddle Mountain, The Castle, Mt. McIntyre and Wicher. This agglomerate was accumulated as an irregular flow of granite or gneiss, as shown by local projection of granite through it, and the occurrence of the agglomerate in valleys and hollows. The breccia forms mountain masses and table lands, sometimes capped with andesites.

The constitution of the mass of breccia is that which is characteristic of accumulations about great centers of violent and repeated volcanic outbursts. Massive andesites and trachytes also form hills and mountains within the general area. They are, according to Cross, more recent than the earliest portion of the great brecciias.

Rhyolite is a pale gray, or pinkish rock, banded and light colored, with occasional crystals of glassy feldspar in it and some mica. It occurs in small masses, remnants of a once extensive but thin surface flow, such as appear here and there scattered about over the Florissant lake basin. A local center of andesitic eruption occurs near the village of Truro. The rocks of this volcanic area are very fresh.

Near the center of High Park are prominent hills of tuff and andesitic agglomerate. Southward the overflow of the park is covered with thin rhyolite; andesitic tuffs are younger than the rhyolite.

In the hill on the eastern side of the park the lake beds are found between flows of rhyolite and phonolite. This is the most western occurrence of the phonolite so far as known.

The Bare Hills represent the site of a vent of andesitic eruption. The earliest eruption produced a fine grained light colored tuff full of fragments of granite. Penetrating this tuff are necks and dykes of hornblende mica, andesite according to Cross. The surface masses erupted through these channels built up the higher portion of the hills resting upon the tuff or outlying granite. In the southern region are patches of andesite resting on rhyolite breccia.

Of the outlying phonolite masses around Cripple Creek center these range from a point on the slopes of Pike's Peak itself, seven miles northeast of Bald Mountain, to Nipple Mountain on the south and High Park on the west. The larger bodies are either sloping dykes or surface masses from sources immediately below them.

East of Little Pisgah peak a large irregular peak of phonolite cuts the granite on the rugged cliffs facing Wilson Creek. A great many dykes of phonolite are found in granite on all sides of the volcanic center.

Though the sedimentary beds are of little importance to the prospector, some of them are of much geological interest, especially that known as the Florissant basin. This represents a primeval lake of the Tertiary period, around which volcanic vents were active, sending in their explosive eruptions, clouds of volcanic cinders and dust into the air, which, falling into the lake, formed the coarse and fine sediments which lined its bottom. In this volcanic tuff and coarse sandstone are numerous fossil insects, leaves of trees, trunks of trees of Sequoia or California big tree, and one or two birds. The length of the lake is about fifteen miles, and its width is very irregular. The predominant material composing the fine shales and sandstones is andesitic, with detritus of basalt and rhyolite, and belongs to the earliest volcanic eruptions of the volcanic center lying westward of the mapped area.

Dark basaltic flows of breccia and remnants of rhyolite flows rest on the Florissant tuff at many points. The Alnwick and High Park lake beds represent local lakes of a period still more recent than the Florissant.

As general hints to the prospector in this region we would suggest: Confine your attention and researches mainly to the eruptive lavas, and to such portions of them as may appear locally most decomposed. Look out for any signs of veins or hot spring action, such as veins of quartz or calcspar. The contact lines between all dykes and other rocks should be examined. In fact, anywhere where ascending hot solutions would be likely to penetrate.

Of the kinds of lavas, probably the basalt, a very dark, almost black rock, is less likely to be productive than the andesitic, rhyolites and trachytes. It is probable, also, that locally veins may be found in the granite or dykes of lava penetrating the granite. The harder and fresher looking the lavas, the less likely are they to carry ore.

THE SARDINE FISHING INDUSTRY IN NEW BRUNSWICK.*

By Prof. PRINCE, Commissioner of Fisheries.

PASSAMAQUODDY Bay, New Brunswick, and the waters around the West Isles, in the Bay of Fundy, have long yielded an abundant supply of herring. These have been commercially utilized in various ways. Formerly they were smoked or pickled and packed in barrels, but during the last twenty years, with the decline of these branches of the fish-curing industry in the province, there has grown up a sardine fishery which has become of great importance and value.

In speaking of a sardine industry it is well to premise that the occurrence of the true sardine in Canadian seas has not been scientifically established. Sardines are fish of insignificant size, when adult, but those called by that name in Canada are, in reality, the young of the herring and allied clupeoids. The opinion expressed a year or two ago in a Quebec journal (L'Evenement, June 5, 1893) by an acknowledged authority, with reference to the sardines canned on the banks of the St. Lawrence (Kamouraska) accurately represents the fact in regard to our sardines generally. "J'ai eu raison de dire qu'il n'y avait pas de sardine dans le St. Laurent et que ce que M. Letellier met en boîtes à St. André de Kamouraska n'est que du petit hareng." The small and immature condition of these fish by no means detracts from their comestible qualities. Indeed such qualities do not in all cases improve when the large, full grown stage is attained, and the adult of such clupeoids as the gaspereau is of inferior excellence, whereas the immature fish is delicate and toothsome.

The small fish, the capture of which constitutes the New Brunswick sardine fishery, are prepared and packed either in shallow rectangular tins or boxes or in oval cans after the manner of the familiar sardines à l'huile, which have long formed a valuable industry in France. The sardine canneries have been chiefly, and are at the present time almost solely, carried on upon the coast of Maine. The three canneries in Charlotte County, New Brunswick, viz., that of Mr. Lewis Holmes, Beaver Harbor; Mr. Theodore Holmes, St. Andrews, and Mr. G. K. Wetmore, Deer Island, do not affect the general statement, as the pack of these establishments is but an inconsiderable item when compared with that of Eastport and other canneries.

The sardine cannery in the province of Quebec, already referred to, may be excluded from present consideration, although, from the high excellence and repute of its production, it occupies a notable place in the fishery industries of the Maritime Provinces.

At or near Eastport, Me., there are or were, until recently, no less that thirty-five sardine factories, a number increased by the addition of sixteen new establishments to over fifty, or nearly as many as are occupied in the famous French sardine industry, packing, in 1892, 300,000 cases, which was a considerably smaller pack than in the preceding year. From season to season the number of establishments varies as new canneries are opened and old ones closed.

When the packing of sardines commenced, nearly thirty years ago, considerable quantities were put up in factories in Canadian territory. A prohibitive duty imposed by the United States wholly altered the industry from a Canadian point of view. The supplies of fish, it is true, were obtained in our waters, but the market for the manufactured article was chiefly in the United States, and by a convenient interpretation of the customs regulations, which practically would have kept out even freshly caught fish, these fish were admitted into the United States. The United States attorney-general gave the decision that Canadian boats of less than five tons burden might be regarded as not vessels in the meaning of the regulations, and the Canadian fish required for the Maine sardine canneries were thus admitted as the product of American fisheries. The United States canneries could not carry on their operations for a single day but for the ample supplies of fish obtained from our waters, and the sardine industry, so far as our fishermen are concerned, is confined to the capture of the fresh fish and their disposal to the Maine canneries. At least 95 per cent. of the so-called United States sardines are caught by our fishermen on Canadian shores, and these are, for the most part, packed in Eastport, Lubeck and other small towns in the State of Maine.

Of such importance is the supply of these small fish that a large proportion of the population on the Maine coast, as well as the body of Canadian fishermen who pursue their calling among the islands of the Bay of Fundy and neighboring waters, may be said to be largely dependent upon the sardine industry. A failure in the supply of these fishes would mean disaster to those engaged in cleaning, curing and packing, and who have capital invested in the canneries, and would, without doubt, seriously affect the Canadian fishermen who find lucrative employment in the capture of sardines. That the small fish, known as sardines in these waters, were abundant on the shores of Charlotte County, N. B., was long known to our fishermen, but their value was not appreciated, and the only use to which they were turned was that of conversion into manure for the purpose of fertilizing the land.

Sardines are captured in weirs (the name being pronounced "wires" in the locality), which are really walled inclosures or traps built of woven twigs, with wooden supports or posts driven into the sand at distances of six or seven feet apart, in comparatively shallow water. Smaller posts and horizontal stringers are used to secure additional strength. The weirs vary in form according to their position and the particular character of the shore. They consist essentially of a wall or leader, sometimes two or more leaders, terminating seaward in a pocket or trap. This pocket or trap may be circular, heart-shaped or triangular in form.

The fish, as they move along the shore, are guided by the leaders through the narrowing openings into the heart, and their return is prevented by projecting partitions. When once the fish reach the terminal heart they make little attempt to escape, and may be kept impounded without suffering harm for a period of many days, if the tide does not recede too far. Such brush weirs as just described will last for six or seven years, but in order to avoid risk or damage by storms and drift ice in winter many fishermen take the precaution to carry ashore a large part of the twig, wattling or brush used in the trap. The best position for a brush weir is without doubt at the extreme end of a tongue of land, especially between islands or rocky ledges, where the currents run smooth and swift.

The movement of the water when the tide flows often carries the school directly into the trap, or when heading against the tide they are said to "stem in." As a rule, the fish enter the trap at night, and on bright moonlight nights, and during the day they appear to be afraid of the weir, and as a rule shrink from entering it. It is remarkable that the fish when entrapped make no attempt to escape, though there are considerable spaces between the wattled twigs, especially when the weir has been recently built. Such openings become, to a large extent, filled up by weeds and debris, so that the walls of the weir, in the course of the season, increase in thickness and density, but are kept sufficiently clear to admit of free ingress and egress of water when the tide ebbs and flows. The poles and twigs, moreover, become thickly coated with mussels, zoophytes, etc., these having become attached when the creatures were in the young floating condition. Except for occasional repairs, the weir is a self-fishing device, and requires little attention. In many cases the fishermen's houses are a short distance away, but in other instances the fishermen must row a distance of two or three miles in order to secure their catch. The fish come in with the flood tide, very rarely at the commencement of ebb, and migrate into the shallows, attracted probably by food. A messenger, usually a boy, is dispatched to the weir as the water begins to lower—soon after "high slack" during the day or after nightfall, and if he reports, on his return, that fish are in the "heart," the men, two or three, or more if the weir be very large, proceed to secure the catch. Often, when the men are of opinion that the tides are "off," they omit to even inspect the weir, as they do not expect to find any fish. The catch varies greatly. Some weirs, favorably situated in narrow channels, which form favorite passages for the fish, may secure a catch worth $700 or $800 at a single tide. The quantity of one catch on Grand Manan is reported at 400 hogsheads—that is, 2,000 barrels. Fortunate lessees of weirs have realized as much as $10,000 to $20,000 in a year as the return of a single weir, but this return is, of course, very exceptional. Storms and winds, the state of the moon and other circumstances affect the movements of the fish, and, in consequence, the value of the catch. June, as a rule, is a moderate month, but there is often an improvement up to September. October and November are variable, but often are good, while in December the catches have been large, but in the early months of the year the fishery is not worth carrying on. So variable is the quantity of fish and the time of their appearance that for weeks and months it does not pay to fish the weirs. During the periods when the weirs are neglected they must continue to catch fish of various kinds, and such fish are wasted and lost. This waste has suggested the desirability of providing a door or outlet for the escape of the fish at these times. Indeed, some such provision is desirable on many grounds, for during the fishing season schools of small fish are entrapped for which there is no market, and such fish should have a means of escape provided.

The ease with which the weirs are worked tends to induce indolence and lack of enterprise on the part of the fishermen, who, unlike their brethren on the open sea, endure little hardship, labor or danger. They are not required to seek the schools of fish, but may be said simply to wait until the fish come in and entrap themselves.

The fish inside the weir pass backward and forward from end to end of the inclosure, but are not observed as a rule, to make any attempt to escape by the open entrance, shoreward, by which they gained entrance. The interstices between the wicker work would apparently afford means of escape—at any rate, to the smaller fish—but they are observed to keep at some distance from the walls of the trap; the multitude of fish, large and small alike, move in a body backward and forward, or migrate round and round the trap. Small herring fry and post-larval silver hake often occur along with the larger fish, but these diminutive specimens, 2½ or 3 inches in length, remain with the rest and are not observed to take advantage of the spaces and openings in the walls.

It is clear that nothing less than a spacious door, to be opened when required, will save even very minute fry from destruction. Sometimes the swift outflow of water, as the tide falls, will carry small specimens almost through the interstices, but they are observed to wriggle violently toward the center of the inclosure and to rejoin the main school.

When the fishermen have arrived at the weir, they wait until the water has lowered sufficiently and then proceed in the weir boats to seine the catch. These weir boats, of which two are generally used, are heavy and scowlike, measuring 15 or 20 feet in length and costing from $70 to $200.

The seine is fastened by one end to a post, usually in the deepest part of the trap, and the other end is carefully carried round, until both extremities are brought together. Thus the fish are gradually inclosed as the net is swept round. The alarmed fish rush hither and thither in great terror, as the area of the net diminishes around them, and if any risk appears that they may escape, one of the boats is rowed about in order to intercept them, the men in the meantime stamping with their feet on the bottom of the boat, and beating the water with oars and staves, driving the fish by their noses back into the pocket until finally they are massed in the bunt of the seine, and are then scooped out with capacious dipnets. The canneries send boats round to the various points where weirs are placed and collect the fish. Fresh sardines are sold by the hogshead, equal to about 15 bushels, and the skipper of the cannery boat usually bargains for them on behalf of the factory. When several buyers are desirous of securing them a kind of auction takes place. Up to 1885 the price paid was, as a rule, $5 per hogshead, but the rate now varies extremely, and may run up to $30, $50, or even $100, especially when the fish are scarce. Six dollars per hogshead is not considered a very remunerative price, and when, as in rare cases, the rate has fallen to $2.50 to $3, the fishermen prefer to use them for other purposes than canning, and sell them for smoking. The preparation of smoked herring was at one time an important Canadian industry, but it has fallen off to such an extent that it cannot now be regarded as other than a decaying industry. Such herring as are destined for smoking are largely shipped to Eastport, where they are smoked in United States factories by arrangements with the Canadian fishermen, in order to escape the duty of 3¾ cents per box, levied on prepared fish shipped into the United States. Many smoking sheds in New Brunswick and Nova Scotia have been taken down and removed into Maine, but the weir fishermen receive the advantage of increased prices for fresh herring suitable for smoking. Small and undersized herring are not fitted for smoking purposes, and if diminutive are refused by the canners, who have a minimum size for the fish they handle.

* From the report of the Department of Marine and Fisheries.

HINTS FOR THE HERBARIUM.

By BESSIE L. PUTNAM, Harmonsburg, Pa.

IN making collections for the herbarium, many bulky and seemingly unmanageable parts are discarded by amateurs, which might be reduced by exercising a little ingenuity, patience and perseverance, quite within the desired compass. Strickly speaking, a specimen is not complete that does not show all parts in the various stages of development—different forms of foliage, vernation, buds, blossoms, fruit, seeds, rootstocks, etc.; yet how few attain this ideal.

As a means toward approximating it, F. H. Knowlton, in his "Directions for Collecting Recent and Fossil Plants,"* advises the postponement of mounting specimens, save in the case of rare plants not likely to be found again, until considerable experience has been acquired in collecting and in general herbarium work. That the earlier attempts will prove crude and incomplete compared with those in which months or even years of experience form a factor, cannot be doubted. Yet the home collector who adopts this plan will do well to practice mounting on cheap paper; for there is a knowledge gained in mounting that largely aids in the selection and preparation of material for the permanent collection.

The larger fruits, such as acorns, are many of them necessarily consigned to boxes kept for the purpose. Stiff paper folded to resemble small envelopes is often attached to the side of the herbarium sheet as a receptacle for the smaller seeds, detached flowers, etc.

Our earliest spring flower, the skunk cabbage, is usually looked upon by those commencing the study of botany not only as an undesirable but an unmanageable subject for the herbarium, when in reality it is very easily reduced to the proper limits. The globular spadix is so completely enveloped by the thick, hooded spathe as to render it almost if not completely invisible if pressed in situ. Thus its removal gives the twofold

* Part B of Bulletin of U. S. Nat. Museum, No. 39.

advantage of showing its structure and lessening the bulk.

An attempt to remove it through the narrow opening in the spathe would probably result in tearing the latter so as to ruin it. By cutting an aperture in the back of the spathe with a sharp knife, the spadix may be easily removed; and when mounted, the opening will not be visible. The spadix may be split into halves and pressed. One thus treated now lies before me, each half of which is reduced to less than one-eighth of an inch in thickness, while the pressed spathe is no more bulky than thick paper and is somewhat pliable. In mounting, one-half of the spadix will be turned to present the internal structure; the other, the closely packed blossoms.

By digging down at the base of the flowers, one will find seemingly small bulbs just commencing to send forth leaves and rootlets. These are in reality germinating seeds, and may be easily pressed by sectioning.

To those who have been deterred from experimenting with skunk cabbage on account of its repulsive odor, I would say that this objection is scarcely noticeable after the first few days; and when the plant is thoroughly dry, I very much doubt if the most sensitive olfactories would be able to identify it by the odor.

The beautiful flowers of our native whitewood or tulip-tree are easily managed; the fruit, however, is not so readily disposed of. The writer has obtained satisfactory results by first removing a section from one side—the side which is to be placed next to the paper in mounting. Yet even the half cone projects upward so far that the surrounding foliage will become curled in drying unless extra precaution is taken. To prevent this the leaves were submitted to the pressure of a warm iron until all moisture was removed. Then the specimen was placed under a heavy press, and received the usual treatment of having the driers changed once or twice every twenty-four hours. As it became dry the winged seeds showed a tendency to fall, especially along the line of incision. A generous supply of mucilage was then filled into the interstices laid open by sectioning, and this proved sufficient to hold the seeds so firmly in place that a journey of over five hundred miles was afterward safely made in Uncle Sam's mail-bag.

A fluffy head of dandelion seed would be about as likely to attract the inexperienced collector as a flake of snow, and would doubtless prove scarcely less evanescent in his hand. Yet no better illustration can be cited of the possibilities in this line than the following description given by Mr. Walter Deane in a recent number of the Botanical Gazette:

"I have succeeded in mounting a specimen of our common dandelion with the large head of fruit intact. I did it in this way: I collected the specimen the moment the fruit had opened, and while the akenes were still firmly attached to the receptacle. In this condition I pressed it. By the time the plant was dry, I noticed that the akenes were free from the receptacle, but still in position. I always transfer all my plants too flimsy to handle to the mounting sheet or pasting sheet of blotting paper by reversing the plant with a sheet on each side. This saves much trouble and the most delicate plants can in this way be very quickly handled and mounted. In the case of my taraxacum, however, I could not touch the pasting brush to the pappus on the fruit, as it would stick to it and spoil my specimen. So when the plant was on the mounting sheet unpasted, I made a few points with a pencil close to the edge of the pappus. Then, after transferring the plant to the pasting sheet, I pasted all the plant but the fruit, and, on the mounting sheet, I pasted the space between the points. By careful reversal of the plant again, the fruit fitted exactly on the former spot, where the glue received it and held it fast. A few blotters and a proper weight, laid on the sheet for a few hours, completed the work."

The collector who resolves to make as complete specimens as possible will readily supplement these few suggestions by many original devices, for the field is rich in possibilities. And the satisfaction of having performed a difficult work, added to the increased efficiency which approximate completion of the specimens gives to the practical value of the herbarium, should be sufficient incentives to all collectors to put forth their best efforts.—Education.

[Continued from Supplement, No. 1075, page 17179.]

THE SHADE TREE INSECT PROBLEM IN THE EASTERN UNITED STATES.*

THE WHITE-MARKED TUSSOCK MOTH.

(Orgyia leucostigma Smith and Abbot.)

Original Home and Present Distribution.—This insect is a native of North America. It ranges from Jacksonville, Fla., to Nova Scotia, on the eastern coast, and extends west certainly as far as Keokuk, Iowa, and probably farther, although the records at command include no actual captures beyond this point. It does not occur in California, so far as learned.

Food Plants.—It attacks almost every variety of shade, fruit and ornamental trees, with the exception of the conifers. In the City of Washington it seems to select by preference the poplars, soft maples, the elms, alders and birches, as well as the willows. It is also found here on apple, pear, cherry, plum, peach, other varieties of maple, locust, box elder, ash, catalpa, rose, horse-chestnut, persimmon, sycamore, mulberry, and a number of other trees.

Life History and Habits.—This insect passes the winter in the egg state. The overwintering eggs are laid by the female moth in the latter part of September, in a glistening white, frothy-looking mass attached to the outside of the cocoon. They are seen at a glance, owing to their pure white color, and remain conspicuously upon the trees until spring. The caterpillars hatch in Washington in April and May. They are represented at different stages of growth in Figs. 4, 5 and 6, and in view of the care with which these figures have been drawn, detailed descriptions will be unnecessary. They cast the skin five times, exhibiting a different character after each molt, as indicated in the figures. The newly hatched young feed on the under surface of the leaf, eating off the parenchyma and producing a skeletonized appearance. After the first molt the skeltonizing continues, but a few holes are eaten completely through the leaf; after the second molt many holes are eaten through between the main ribs, and after the third molt the leaf is devoured, except for the midrib and its principal branches. After the fourth molt the caterpillars begin to eat from the edge of the leaf and devour everything except the principal veins. Similar work is done in the last stage upon the full-grown and tough leaves (Fig. 7).

A most peculiar kind of damage by the caterpillars of this species has been observed by Dr. Lintner in Albany, N. Y. There, in the summer of 1883, he found that the tips of many twigs were girdled by the caterpillars, which had entirely removed the bark for a tenth of an inch. Such twigs broke off and fell to the ground, with their leaves. This damage was so common in 1883 that the sidewalks of the streets and public parks, wherever the American elm was growing, were sprinkled with the newly fallen leaves. Dr. Lintner was of the opinion that a cold spring and the sudden advent of warm weather caused an unusually vigorous growth of the terminal twigs, and that the young tips were therefore unusually tender. They thus proved appetizing to the tussock moth caterpillars, which developed a new habit for the occasion. This peculiar damage was repeated in 1895, but to a less extent. No other observer in any part of the country has ever reported similar damage.

The young caterpillars drop down, supended by silken threads, at even a slight jarring of the tree, and frequently spin down without such disturbance, and are blown to a considerable distance by the wind. When nearly full grown they are great travelers, crawling down the trunk of a tree upon which they were hatched and across a considerable stretch of ground, to ascend another tree. When they occur in numbers, an extensive migration will always take place from a tree which has been nearly defoliated, and the species spreads mainly, if not entirely, in this way. Just as is the case with the gypsy moth, the caterpillars are carried by vehicles, upon which they crawl or drop, or upon the clothes of passers-by, and in this way many trees upon which there were no egg masses become infested.

The larval state lasts, on an average, from a month to five weeks. When full grown, the larvæ spin delicate grayish cocoons of silk mixed plentifully with hairs. The mixture of hair is brought about by the fact that the hairs are barbed and rather loosely attached to the body. When a caterpillar begins to spin its cocoon, the hairs of its body and those of the long, black tufts on the prothorax first become entangled with the silken threads and are pulled out. By the time the cocoon has begun to take shape, the characteristic long, black tufts of hair have entirely disappeared from the body of the caterpillar. Later the shorter hairs of the sides of the body become entangled and removed, and finally many of the hairs composing the brush-like tufts upon the forepart of the body are pulled out; and just before it transforms to pupa the caterpillar bears but a remote resemblance to the individual before it began to spin.

The barbed hairs just mentioned may occasionally produce considerable irritation of the skin of people upon whom the caterpiliars may have crawled or dropped from the trees. The hairs from the different portions of the body of the full-grown caterpillar are illustrated, greatly enlarged, in Fig. 6, and it is the shorter hairs from the sides which probably cause the irritation. They are very small, fall out readily, and when a caterpillar crawls over the skin of an individual who is warm and perspiring these very sharply barbed hairs produce an irritation which in some individuals has been the cause of much discomfort, creating more or less inflammation and swelling.

The larva transforms to pupa within a few hours after the completion of the cocoon, and remains in the pupal condition from ten days to two weeks. The cocoons of this first generation, while mainly spun on the trunk and larger branches, are also spun to a very considerable extent upon the smaller branches and twigs, and even on the partly eaten leaves.

The adult insect presents the rather unusual phenomenon of a winged, active male and a degraded, absolutely wingless female. It is this fact which makes the spread of the species dependent upon the traveling powers of the caterpillar, as mentioned in the preceding paragraph. The male and female pupæ and the male and female moths are so well shown in Fig. 4 as to need no description.

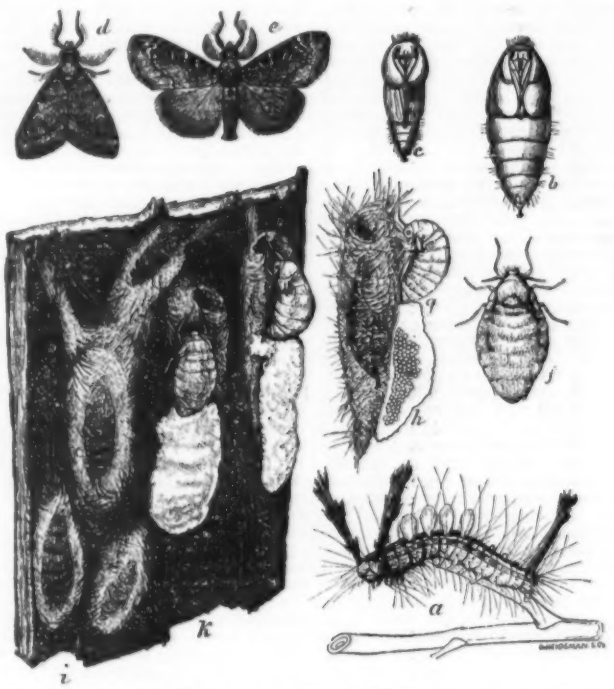


Fig. 4.—Orgyia leucostigma. a, larva; b, female pupa; c, male pupa; d, e, male moth; f, female moth; g, same ovipositing; h, egg mass; i, male cocoons; k, female cocoons, with moths carrying eggs—all slightly enlarged (original).

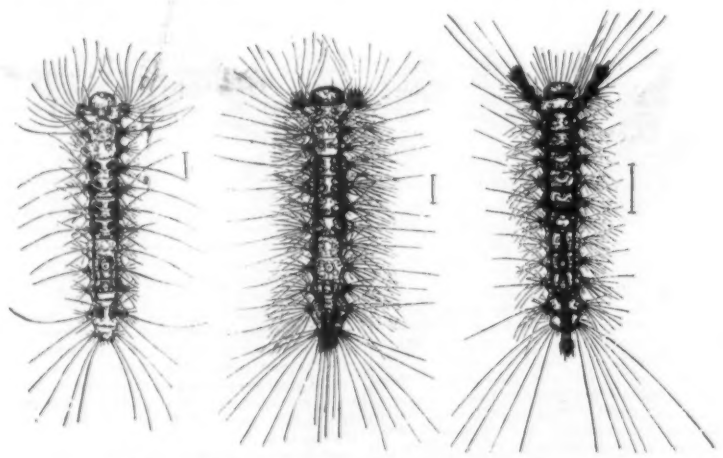


Fig. 5.—Tussock Moth Caterpillar. First, second, and third stages—enlarged (original).

Coupling takes place upon issuing from the cocoon, and immediately afterward the females begin to lay their eggs, clinging firmly to the cocoons from which they have issued and attaching the egg mass to the lower half of the cocoon, in the manner shown in Fig. 4, h and k. As soon as the eggs are laid the females die, and usually fall to the ground, although sometimes their shriveled bodies remain, clinging by the legs to the upper part of the cocoon.

We have made no observations as to the duration of these midsummer eggs. Unfortunately, upon the length of time which elapses before hatching depends exact information as to number of annual generations.

* By L. O. Howard, M.S., Entomologist United States Department of Agriculture. [Reprinted from the Yearbook of the United States Department of Agriculture for 1895.]

Specific observations the past season in Washington were not begun until August 15. At that time the egg masses were everywhere to be seen and about that time the eggs began to hatch. From the early statements of Riley it was assumed that these were the eggs of the second generation, but reference to the notebooks of the office shows that on several occasions overwintered eggs have hatched in Washington in April, and adults have issued as early as the middle of June. From the middle of June to the middle of August is certainly long enough to allow for a generation of this insect. Assuming that such a generation had developed, larvæ from these August eggs would belong to the third generation. This, however, is to a certain extent guesswork, and the regrettable lapse of observations during the last half of June, the whole of July, and the first of August can be remedied only in another season.

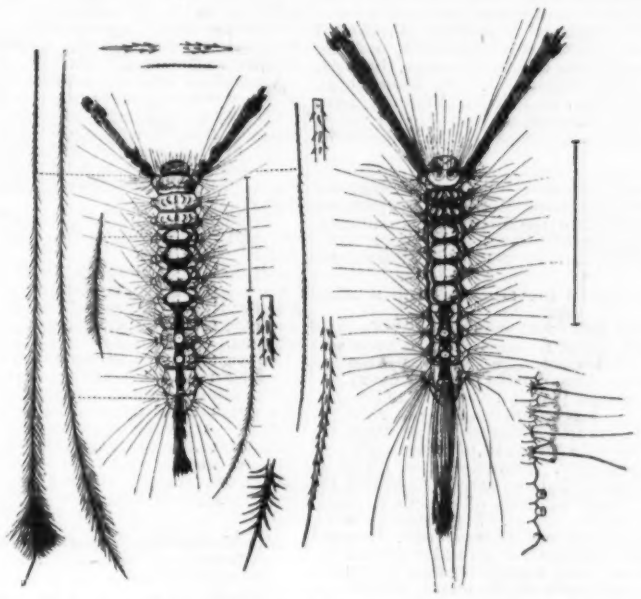


FIG. 6.—Tussock Moth Caterpillar. Third and fourth stages, showing enlarged hairs from different parts of body (original).

Elaborate observations were made upon this August brood, the individuals of which were present in extraordinary numbers. Certain of the larvæ under observation, which hatched on August 2, commenced to spin up on September 3, and on September 14 the first male moths made their appearance, the first females issuing September 19. During the latter part of September the bulk of the moths issued, and the conspicuous white egg masses were very abundant by the 1st of October. Many of these egg masses were kept under observation from that time on. In the cold room of the insectary (temperature the same as outdoors) a few eggs hatched about the close of the second week in October, and on October 23 two newly hatched larvæ were observed upon an egg mass collected out of doors. This late fall hatching, however, is probably exceptional, but in a late, warm autumn it is likely to be rather general. It is hardly to be supposed that any individuals hatching after the 1st of October will successfully transform. The cocoons of this late fall generation are almost invariably spun upon the trunk of the tree and in the crotches of the main limbs, but occasionally, in the case of large trees, upon the larger limbs themselves. The tendency of all the larvæ of this generation is to crawl toward the ground before transforming. Cocoons are occasionally spun upon fences or other objects near the trees upon which the larvæ have been reared, but the vast majority are found upon the trunks.

There are, then, certainly two, and probably three, annual generations at Washington. In New York and Brooklyn there are two well marked generations. At Boston, as is learned from Mr. Samuel Henshaw, there are two generations. Farther north, however, although the statement is based upon no exact observation, it is not at all likely that there are more than one, and, as stated in the introduction, the comparative harmlessness of the species in such regions is probably due to the nondevelopment of the second generation.

Remedies.—There are two classes of remedies as well as an excellent preventive that may be used to advantage against this insect. These are the collection or destruction of the eggs in the winter, spraying the trees against the larvæ, and banding unattacked trees to prevent the ascent of the caterpillars and the subsequent development of moths and the laying of eggs.

The collection and destruction, or the destruction without collecting, of the eggs must be thorough in order to have any practical efficacy. The great majority of the hibernating egg masses are deposited low down on the trunk of the tree or upon the main limbs, so that they can be reached in one way or another without much difficulty. The egg mass is compact, and, being attached to the somewhat flimsy cocoon and not to the bark, it is easily removed either by hand or by scraping it off. The egg masses which have been scraped off must not be allowed to remain at the surface of the ground, but should be collected and burned. A scraper for the removal of egg masses which occur too high to be reached by hand has been devised by Mr. Southwick, of Central Park, New York City, and consists of a very small hoe blade at the end of a long pole. Perfectly unskilled labor can be utilized in this operation, but the workman should be impressed with the necessity of absolute thoroughness; not an egg mass should be overlooked. In the work against the gypsy moth in Massachusetts it has been found that the egg masses cannot be removed to the best advantage by means of scrapers. The eggs are attached, not to the cocoons, but to the bark of the trees, and certain eggs may be left in the attempt to remove the mass. An extensive series of experiments has therefore been carried on, with a view to securing a liquid which will penetrate and destroy the egg masses.

FIG. 7.—Silver maple leaves eaten by larvæ of white-marked tussock moth in successive stages of growth from a (newly hatched larvæ) to f (full grown larvæ)—reduced (original).

A satisfactory liquid for this purpose has been found in creosote oil, to which turpentine is added to keep it liquid in cold weather, with tar to blacken it, so that treated egg masses can be recognized at a glance. The workman is furnished with a pole, to the end of which a small sponge is tied. He goes from tree to tree, dipping the sponge occasionally into the creosote preparation and touching with it each egg mass found. This is a simple and very rapid method. It has the advantage of rapidity over the scraping method described above, since after the eggs are scraped off they must be collected and carried away for burning.

A modification of this plan may be used to advantage against the tussock moth. The pure white color of the egg mass of the tussock moth, however, renders the use of coal tar in the preparation unnecessary, since the creosote oil alone will discolor it enough to render a treated mass recognizable at a distance.

No explicit directions for spraying with arsenical poisons against this insect are needed. The same liquid and the same apparatus that are used against the elm leaf beetle may be used against this insect, and the spraying may be done at about the same time of the year. It is essential that the caterpillars of the first generation shall be killed, as the second and more destructive brood will thus be prevented.

Banding of the trees is practiced to advantage with this species. It is the only one of the shade tree insects, except the bagworm, which has a wingless female. All the others, except the gypsy moth, spread from tree to tree by the flight of the female. Many experiments have been made with different styles of bands, and it has been practically proved that a broad, thick, strip of raw cotton, tied about the trunk of the tree with a string, is after all the most efficacious and perhaps the cheapest. Such bands have to be renewed occasionally, as they become more or less matted together and spoiled by rainstorms.

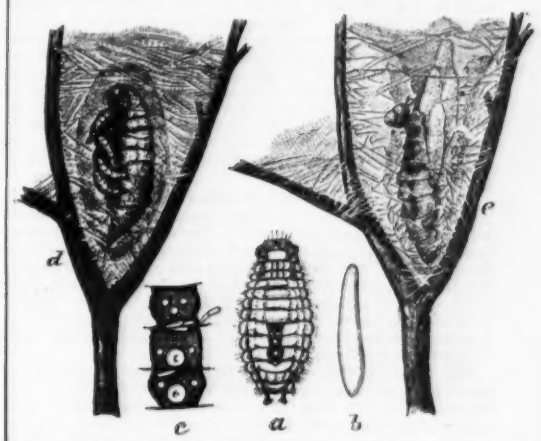


FIG. 8.—Ichneumonid parasite of tussock moth caterpillar. a, parasitized caterpillar; b, egg of parasite; c, same in situ; d, parasite larvæ issuing; e, parasite cocoons—all slightly enlarged, except b and c, which are much enlarged (original).

Next in point of efficacy will probably come bands of insect lime, several brands of which are on the market. Insect lime is a sticky, coal tar product, which retains its viscidity for a considerable time. A ring made around a tree will remain operative for some weeks in warm weather.

(To be continued.)

INDUSTRIAL AND TRADE SCHOOLS IN GERMANY.*

No attempt has hitherto been made to present in a concise treatise the subject of the condition and organization of Prussian continuation and industrial schools in general, and those of Berlin in particular. This deficiency, together with the fact that the limits of the different kinds of continuation schools are hard to define and not infrequently encroach upon one another, increases the difficulty of a presentation which is based upon official reports and the contributions of an Austrian specialist who himself inspected the institutions of Prussia.

Many boys in Germany leave the common school before they have attained the end it has in view. They cannot express their own thoughts distinctly and intelligibly, correctly understand the expression of the thoughts of others, or give a quick and correct solution of simple arithmetical problems, either mentally or in writing. These acquirements are indispensable, however, to the mechanic as well as the farmer, to carry on his trade or follow his pursuit with advantage, and to protect himself against losses.

In Prussia, as in other German states, all these causes have for many years combined to urge the establishment of continuation or supplementary schools. Until twenty years ago little attention was paid to this subject in the old provinces of the kingdom; less even than in those acquired in 1866, where other conditions prevailed. In Nassau and Hanover industrial schools, so called continuation schools, received appropriations from the state which Prussia transferred to the account of the department of commerce and continued to pay.

After much consideration and discussion it was decided to increase this state appropriation for 1874, and turn it over to the minister of public instruction, under the head of "Appropriations for industrial and continuation schools." An official order of 1878 compels factory owners and managers not only to permit their workmen under eighteen years of age to attend continuation schools obligatory by local statute, but to allow every individual attending them the amount of time decided upon by competent authority. Consequently, as journeymen, apprentices, or workmen could not be prevented from attending the optional continuation schools without the employers incurring the risk of punishment, the department of public instruction was ever more ready to allow larger appropriations for the support of these institutions.

The rural continuation schools of Prussia are inconsiderable in number and are unequally distributed among the different districts. As communities, besides furnishing the buildings, as well as heat and light, until recently bore half, and at present bear at least a third of the other expenses, not covered by a rather

* Digest of report by Mr. L. R. Klemm, of the Bureau of Education, Washington, D. C.

large school tax, the number of these schools is proportionately small and varying.

Industrial or city continuation schools consist of two grades of several classes each. The instruction as given in the lowest grades advances the general education of pupils with special reference to their calling, and consequently practically embraces all subjects of the higher classes of advanced common schools excepting religion. The special aim of the advanced grades is the pupils' acquirement of industrial proficiency; in the selection of studies, local industrial relations are taken into consideration.

By industrial continuation schools, we understand all institutions which offer the opportunity to anyone engaged in industrial pursuits of any branch or condition whatever, whether apprentices, journeymen, or masters engaged in labor during the day, to acquire a partly general, partly professional, education, always based upon the necessity of a practical business life. The state pays the greater part of the expenses. Since the passage of a law in 1886, purely public trade schools exist only in west Prussia and Posen, but only in the larger centers of industry. Instruction here is entirely gratuitous and obligatory for all workmen not over 18 years of age. This law was a political measure aimed at repressing the efforts of demagogues to gain disciples among the young, and preserving and developing in children the elements of a German education begun in the common schools. In 1890 there existed altogether 159 of such trade schools, with 12,000 pupils in round numbers, while Prussia numbers 1,105 industrial continuation schools.

Besides the above mentioned there are a number of private schools which are simple industrial continuation schools established by societies, labor unions, or guilds; but as far as the education of apprentices by means of instruction is concerned, a guild can get along without establishing its own school, if its members be compelled to allow their apprentices the benefits of the local industrial continuation school, and see that they attend regularly and punctually and are supplied with the necessary school requisities.

The trade school of Berlin is the most comprehensive and most perfectly equipped institution of its kind. It was founded in 1880. The state appropriates 20,000 marks, the city 90,000 marks a year for its maintenance. An advanced Sunday and night school, attended in the winter of 1889-90 by 2,074 apprentices and journeymen, forms the preparatory department of this institution. To this are added two day classes for cabinetmakers and painters and the technical school for mechanics. The Sunday and night school is divided according to separate courses of instruction. Drawing, as the most essential branch, is taught four hours a week, and lessons from two to four hours long are given to classes, so that pupils can be occupied eight hours a week. The lessons embrace demonstrative geometry, mechanics, mathematics, physics, chemistry, electro-technology, arithmetic and bookkeeping.

On the whole no less than 121 courses of four and two hours a week, and engaging 28 teachers, were maintained during the winter of 1889-90. Elementary and professional drawing are taught, and modeling and painting practiced. The method of instruction in all drawing lessons rests pre-eminently on a strictly consistent application of life study, whereby very favorable results are obtained. A special, large building of model arrangement, with electric light for night instruction, abundant collections of accessories and appliances, and all that pertains to a complete school equipment, together with an excellent corps of teachers, are at the disposal of the institution.

A technical school for mechanical engineers is found in connection with the trade school in Berlin. Its particular purpose is the education of foremen and managers of mechanical industries, and especially of expert mechanicians and electricians. The studies comprise a half year's course, which can be extended to a year, and are taught during the forenoon only.

By foremen's schools we understand the lower industrial schools with day instruction, arranged for a whole group of industries. Their curriculum and methods are adapted to a general grade, which need not rank above a good common school, and they admit only practically educated pupils. Their aim is to offer young and old laborers the opportunities of gaining in the shortest possible time such technical knowledge and ability as cannot be acquired in practice or in an industrial continuation school, but is indispensable with the present demands upon a self-dependent manager or foreman in industrial pursuits.

Certain branches of industrial pursuits taken collectively are distinctly separate from others, but may be classed into a greater or smaller number of industrial subdivisions. By being apparently related through their common intellectual foundation, they are naturally combined in one group. There are a number of such branches for whose perfect practice a certain amount of development in art and a knowledge of mathematics, mechanics and chemistry is generally presupposed. To such groups belong the building trades, the mechanic and technological branches, the chemical industry, and the industrial arts.

Schools for instruction in the building trades, the mechanic and technological branches, the chemical industry, and the industrial arts are sparingly represented in Prussia. The most frequent are builders' schools, which are entirely self-supporting institutions. The institution in Berlin, numbering 1,389 pupils (in 1891, 1,192), was formerly connected with the trade school. In 1894-5 this school was separated from the general trade school and made an independent institution, in which the number of students is 381, while the trade school has increased to 3,000 students. Its graduates who pass the final examination, based upon the order issued in 1882 by royal commission, enjoy certain advantages in their occupations. Their diploma, in pursuance of the decision passed by the society of German builders in the year 1888, is accepted in place of the theoretical part of the test examination required by the laws of the society. All builders' unions are further advised in case of special vacancies to consider the graduates of builders' schools, to whom, moreover, the government positions of road and station masters of railroads are open. The various textile industries of Berlin are numerously represented. The United Loom Societies established a weavers' school, which was controlled by the state, in 1883, and the city in 1888 decided upon rebuilding, having the assurance that the state government in future would supply half of the current expenses not covered by actual receipts, and equip the institution with the necessary new machines, looms and other perquisites. The building was completed in 1890 at a cost of 180,000 marks, including the cost of the site. Sunday and night instruction is free to all apprentices and journeymen resident or at work in Berlin; the trustees have granted the same privileges to those beloging to non-resident societies. Others pay 24 marks annually; day pupils 100 marks the first year and 300 marks the second.

As has been stated, societies can establish and control industrial trade schools, provided they observe certain conditions; and the city authorities have the right to allow these institutions the use of city buildings and defray the expense of heat and light. Berlin has 8 of such guild schools, 1 each for printers, painters, tailors, wig makers, and hairdressers, stonemasons, and bookbinders, and 2 for bakers. The other 12 technical schools, 1 each for masons and carpenters, cabinet makers, saddlers, painters, chimney sweeps, barbers, and hairdressers, wheelwrights, glaziers, shoemakers, blacksmiths, upholsterers, and basket braiders, have been established by communities, and are supported by guilds. The state contributes to the support of eight of them.

The Berlin art school, besides preparing pupils for the art academy and educating drawing teachers for higher educational institutions, has for its purpose the instruction of industrial artists in drawing, painting, and modeling, and therefore serves as a preparatory school for the technical class of the royal industrial art museum.

Male and female pupils are admitted, and number over 500.

In connection with the royal manufactory of porcelain in Berlin there exists a school for painters and modelers, the perceptible extension and improvement of which, since 1886, corresponds to the progress in pictorial decoration and the plastic formation of the products of the factory. A separate hall is set aside for painters, in which advanced students are regularly instructed during the whole forenoon of week days and for a few hours on Sunday. The classes are attended not only by journeymen, but, as far as the orders for work justify it, by many painters of advanced years, numbering on the whole over 40. If painters have devoted a long time exclusively to porcelain, they are obliged to occupy themselves for several weeks exclusively with ornametal and nature studies, for which the gardens and greenhouses of the factory supply the plants and blossoms. Journeymen are admitted only when they show decided talent.

Finally, Berlin possesses two business colleges, the first of which was founded in 1885 by private merchants and a union of merchants' guilds. The tuition fee amounts to thirty-six marks per annum, and opens all departments to the pupils attending. Instruction is given four nights a week, from 8 to 10 o'clock. Every pupil has the right to select his own course of study, and belongs to both institutions at the same time, as the hours of instruction do not conflict. The faculty consists of thirty members, the number of pupils averages 1,300, and the curriculum includes commercial geography, exchange and business rules. The state appropriates eight hundred marks annually for both schools.

If we include the city continuation schools and all other similar institutions, even those not supported by the state, besides the different technical schools, over 17,000 persons, or about 40 per cent. of the number under obligation to attend continuation schools, attended industrial classes during the winter of 1891.

INDUSTRIAL AND TRADE SCHOOLS IN BERLIN.
Summary of Statistics in 1894-1895.

Schools.	No of Teachers.	No. of Students.	Expenditures.
First City Trade School	65	2,193	$32,557
Second City Trade School	31	908	14,343
City Builders' School	34	381	21,395
City Weavers' School	30	363	12,006
Central Industrial Hall	53	1,235	10,302
Schools for:			
Cabinet makers	15	755	4,304
Bricklayers	6	253	2,229
Painters	11	388	3,155
Chimney sweeps	5	120	379
Barbers	20	492	1,869
Wheelwrights	5	95	893
Glaziers	5	83	373
Paperhangers	6	250	2,702
Shoemakers	11	228	1,783
Blacksmiths	5	108	522
Braiders	5	57	506
Bookbinders	7	111	1,071
Gardeners	6	98	287
Printers	13	372	1,707
Tailors	6	330	723
Saddlers	3	102	891
Total	326	8,999	$113,182
Extraordinary expenses	.....	.....	15,970
Grand total	.....	.....	129,102
Amount spent for industrial education in continuation schools	.....	.....	80,339
Grand total	.....	.....	209,441

Continuation schools are the only places where, outside of the workshop, hundreds of thousands acquire technical knowledge and proficiency, and next to the church they are the only places where thousands, and particularly all who do not enter the army after leaving the common school, are receiving ethical education, are counseled to practice civil virtue, and trained to order and discipline. If instruction, as it must be, is given in the proper spirit, pupils are not only materially benefited, but they are morally strengthened and awakened to the consciousness that man does not live by bread alone. Whoever is less affected by the ethical than the economical value of industrial continuation schools and industrial education will, nevertheless, recognize the necessity of the powerful and immediate claim expressed by an intelligent Frenchman, who says: "The best instructed industry is at present the strongest." Observation convinces one that the working people depend in a great measure upon industrial education, and that many skilled laborers, designers, masters, and manufacturers have gained their proficiency in technical schools; though the instruction may not in every case have been directly for the benefit of each man's occupation, it has proved to be so indirectly.

SELECTED FORMULÆ.

Practical Antiseptics.—The following are practical antiseptics which every physician can keep on hand ready for any emergency:

Aristol.—This is a non-toxic germicide, used as a substitute for iodoform, and is similarly employed for chronic and syphilitic and scrofulous ulcers.

Betanaphtol.—A solution of 1-2500 for irrigating cavities, cleansing instruments and the surgeon's hands.

Boric Acid.—Affords an excellent all-around dressing. A 5 to 25 per cent. solution to mucous surfaces; an ointment, 1 part to 5 of vaseline; a lotion of salicylic acid 2 parts and boric acid 12 parts, to hot water 1,000 parts, is a safe application to the bladder or cavity of the peritoneum.

Carbolic Acid.—In solution 1-20 to 1-40 for sterilizing instruments or for irrigating wounds or washing sponges. There is a possibility of carbolic poisoning, and children are specially susceptible to its effects in moderate strength solution.

Chloride of Zinc.—A solution of gr. xxx, or xl, to the ounce of water in poisoned wounds—dissecting wounds.

Corrosive Sublimate—The most convenient is to purchase tablets, the strength of which is shown and directions for making the different strength solutions. Symptoms of poisoning must be guarded against. This is evidently the most powerful germicide, but the most dangerous.

Creolin.—Used like carbolic acid, but it is non-poisonous and unirritating to the skin. It is not soluble in water.

Peroxide of Hydrogen.—In 15 volume solution, may be used undiluted, or diluted 10 per cent. A convenient antiseptic for sterilizing all suppurating sinuses and cavities when once open. It may be injected or sprayed.

Potassium Permanganate.—The author keeps on hand 2 grain tablets as the most convenient. Used in foul wounds; various strengths; non-poisonous. And at times a tablet is made wet with water and touched to ulcers, especially abrasions of the os uteri. Used in snake bites, dog bites, and the bites of insects.

These are the principal antisectics, and it is well to have them on hand, not neglecting their use nor confining practice to a single one.—American Medical Journal.

For Shampooing (Shampoo Liquid.)—

Soft soap	2 drachms.
Powdered borax	30 grains.
Alcohol	3 drachms.
Ammonia water, 10 per cent	30 minims.
Perfume	10 drops.
Distilled water	10 ounces.

Dissolve the borax and soft soap in the water by the aid of heat. When quite cold add the ammonia and the perfume dissolved in the alcohol.—Bulletin of Pharmacy.

Restoring Tarnished Gold.—

Sodium bicarbonate	20 ounces.
Chlorinated lime	1 ounce.
Common salt	1 "
Water	10 ounces.

Mix well; apply with a soft brush. A very small quantity of the solution is sufficient for effecting the desired purpose, and it may be used either cold or lukewarm. Plain articles may be brightened equal to new by putting a spot or two of the liquid upon them from the stopper of the bottle and lightly brushing over the surface with fine tissue paper until sufficiently dried off to accomplish the object intended.—Jewelers' Circular.

Typewriter Copying Ink.—

Transparent soap	1 ounce.
Glycerine	4 fluid ounces.
Water	12 " "
Alcohol	24 " "
Aniline dye	Sufficient.

Dissolve the soap in the water and glycerine with the aid of heat; dissolve the aniline in the alcohol, and mix the two solutions. If the ink is too soft, add more soap.—Meyer Brothers' Druggist.

Elastic or Pliable Paste.—

(a)	Common starch	4 ounces.
	White dextrine	2 "
	Cold water	10 fluid ounces.
(b)	Borax	1 ounce.
	Glycerine	3 fluid ounces.
	Boiling water (½ gallon)	64 " "

Beat to a batter the ingredients of (a). Dissolve the borax in the boiling water, then add the glycerine, after which pour (a) into solution (b). Stir until it becomes translucent. This paste will not crack, and being very pliable, is used for paper, cloth, leather, and other material where flexibility is required.—Oil and Colorman's Journal.

A New Lotion for Acne.

Acetic acid	3 parts.
Spirit of camphor	3 "
Tincture benzoin	3 "
Alcohol	50 "

Mix. Apply morning and evening with a sponge.

A New Wart Remedy.—

Salicylic acid	1 part.
Lactic acid	1 "
Flexible collodion	4 "

Mix. Apply night and morning.—British and Colonial Druggist.

Mucilage Cakes.—Soak glue in water until soft, and melt it with a gentle heat. To 1 pound of glue add ½ pound of sugar; mix thoroughly, pour the mass into suitable moulds, and allow it to stand for a few days.

In using the cake, moisten with the tongue.

Sick Room Disinfectant (Meillere).—

Zinc sulphate	64 fluid ounces.
Sulphuric acid	4 " drachms.
Nitrobenzol	1 drachm.
Indigo blue	0·5 grain.

Place about 1 drachm in the bed pan before using. Contact with urine or liquid stools determines prompt solution of this salt, deodorization and sterilization being instantaneous. The excreta are also thus preserved for microscopical examination.

ENGINEERING NOTES.

It is announced that the Brussels paper L'Industrie proposes to have a motorcart competition somewhat after the fashion, though on different lines, to that of The Engineer. Details and conditions are promised to be given shortly.

In connection with this year's Laundry Exhibition at the Royal Agricultural Hall, Islington, Messrs. New & Mayne are arranging an exhibition of "horseless carriages, electric bicycles, delivery vans, motors, marine and aquatic appliances, and all the latest developments of electrical science," to be open from August 24 to September 5.

A popular work on railroading estimates the ordinary load for a ten-ton freight car as follows: Whisky, 60 barrels; salt, 70; lime, 70; flour, 90; eggs, 130 to 160; flour, 200 sacks; cattle, 18 to 20 head; hogs, 50 to 60; sheep, 80 to 100; lumber (green), 6,000 feet; lumber, (dry), 10,000; barley, 300 bushels; wheat, 340; apples, 370; corn, 400; potatoes, 430; oats, 680; and bran, 1,000.

The use of a channeling machine to open trenches in asphalt pavement is being attempted by Wilson and Jackson, contractors, of Chicago. This firm has secured a channeling machine built by the Sullivan Machinery Company, of Chicago, and will use it in cutting through the asphalt and macadam roadways which are being trenched for the electric wire conduits of the new electric lighting system now being constructed by the West Chicago Park Commissioners.

Ten years ago there were four tramway companies in Chicago, capitalized at $11,437,000 and working 90 miles. To-day there are 29 companies, having a capital of $187,208,000 and operating 342 miles. The horse car has practically disappeared, the motive power being: electric, 270 miles; cable, 42; horse, 18; steam, 11 miles. New electric lines now in construction will increase the total city mileage to 400 miles. London has less than three miles of mechanically worked tramways, while the total street length of tramways is only 136 miles, all worked by horse power.

The aggregate length of railway line in operation in France at the close of 1895 was 22,772½ miles, as compared with 22,619⅜ miles at the close of 1894. It will be seen that the extension of the French railway network is proceeding at a materially slackened rate. The cost of the supplementary work proposed to be executed next year upon lines now in working upon the six great French networks is £1,799,600, viz.: Northern of France, £520,000; Eastern of France, £280,000; Western of France, £320,000; Paris, Lyons and Mediterranean, £240,000; Orleans, £160,000; and Southern of France, £279,600. The revenue to March 31 this year is returned at £1,842,240, as compared with £1,805,480 in the corresponding period of 1895, an increase of £36,760.

The New York Central Railroad have been experimenting with a new motor, the power being neither electricity nor compressed air, but hot water stored in supply boilers under high pressure, and then charged, *under* the same pressure, into the battery cylinders of the motor. The experiments have been conducted secretly on the New York Central road for some time past, and it is stated that the results achieved by the new motor have been very satisfactory. Final experiments are to be made soon, which, if successful, will probably result in the adoption of the motor for suburban service. The idea of a hot water motor originated in Germany, but was first practically applied by an American engineer named Lamm, who ran a locomotive charged with hot water through the streets of New Orleans about 15 years ago. The special merit of the motor is said to be its cheapness as compared with the cost of the systems at present in use. Expensive plants are not required and the cars can be run on any track. All that is required is a number of boiler houses along the line.

An experiment made by Howard A. Pedrick, locality not stated, in order to determine the practicability of cleaning large castings by blowing sand against them under steam at a pressure of sixty pounds per square inch, is described in the Iron and Coal Trades Review. It was found that the steam wet the sand, causing frequent clogging of the pipes, and made it next to impossible for a man to stand the severe rebounding of sand from the casting; but after a time compressed air was substituted for steam, and the process was improved until at present ornamental and fancy castings can be thoroughly and cheaply treated in this way, producing an article which would otherwise require much labor to finish. In ordinary classes of work it is practicable to clean thoroughly six square feet per minute, no matter how much ornamentation covers the casting; steel is very hard to clean in the usual manner, but yields readily to the sand blast. The outside appearance of the sand box is like that of a vertical boiler; it is fitted with feed valves and sand chambers, so arranged that an air pressure of about ten pounds per square inch forces the sand through a rubber hose, which must be kept free from kinks.

The transmission or conveyance of gas under pressure to long distances, which was an unsolved problem some twenty years ago, is now a fixed fact represented by the present use of about seventy-five million feet of pipe used in the distribution of natural gas. On the first discovery of this article the pressure at the wells was sufficient to drive it through the pipes almost as far as desired, but, this pressure declining, some additional methods were necessitated, the well known air compressor being resorted to to pump the gas; and, as showing its efficiency, there are at Greenland, in Indiana, gas wells which have long carried supplies to Chicago. There are two eight inch pipe lines used, the gas being pumped a distance of about one hundred and sixteen miles. There is at Redky, Ind., a pumping station of this character that supplies the towns of Springfield, Tiffin, Lima, Dayton, Piqua, and other places in the western part of Ohio. Near Pittsburg there is a gas plant which pumps twenty million cubic feet every twenty-four hours for use in mills, the pumping of this being without the least difficulty; and the Philadelphia company pump many millions cubic feet a day. There are New England air compressors that are pumping every day, at various stations in the United States, the enormous quantity of nearly one hundred million cubic feet every twenty-four hours.

ELECTRICAL NOTES.

According to the New York Railroad Commissioners, 94 per cent. of the street railways of that State are now operated by electricity.

A German cable company with a capital of $890,000 has been formed to lay a cable between Germany and Spain, which will ultimately be continued to the United States.

The new Lake Street elevated railway in Chicago has now been opened for traffic. It is the second to be operated exclusively by electricity. The current is carried by a third rail which is carefully insulated.

In Omaha, Neb., unredeemed dogs are electrocuted. This really seems to be taking a good deal of trouble and expense when gasocution in a lethal chamber as practiced elsewhere affords a cheap, reliable and painless means of killing the stray dogs.

For the purpose of assisting in the detection of icebergs last spring, the American line (according to the American Shipbuilder) had the steamer St. Paul equipped with a 2,000 candle power searchlight, which was carried in an iron cage over the ship's bow at the water's edge.

It may not be generally known, says the Western Electrician, that Wheatstone did not invent the bridge which bears his name. The arrangement was first described by Mr. Hunter Christie at the Royal Society of England, as shown in the "Philosophical Transactions for 1833." Wheatstone redevised it in 1843; he himself acknowledges in his "Scientific Papers" that he did not invent it, a statement which will be found in the "Philosophical Transactions," 1843, page 303.

It is announced that Mr. Nikola Tesla has recently succeeded in producing excellent lighting results from vacuum tubes, one having a total volume of 90 cubic inches, giving about 250 candle power. The efficiency of the light is stated to be much greater than that of the ordinary globe light, and he hopes eventually to convert as much as 40 per cent. of the total energy sent into the circuit into light. A commercial machine for producing the rapidly alternating currents used is now in course of construction.

Demonstrations have been given lately by Mr. Lawson Tait, in London, of his electric hæmostat, an instrument which, as the name denotes, is intended for the arrest of bleeding in surgical operations. A platinum wire, arranged to carry a current, is inclosed in the blades of a pair of steel forceps, or any other requisite instrument, the wire being isolated by a bed of burnt pipeclay. A current of suitable voltage is turned on, the artery seized and compressed, and in a few seconds the tissues and arterial walls are so agglutinated that the passage of blood is rendered impossible. The temperature employed is about 180° F., so that it will be seen that the principle is fundamentally different from that of electrical cauterizing instruments. It is stated, says the Electrical Engineer, that by Mr. Tait's instrument the necessity for a ligature is removed, and a new and completely effective method is placed in the hands of the surgeon for the treatment of surface oozing.

In an address by Thomas Morris before the Staffordshire, England, iron and steel works' managers on the remarkable achievements that have been reached in the manufacture of fine wire, the interesting fact was mentioned that the lecturer had been presented by Warrington, the wire manufacturer, with specimens for which some $4.32 per pound were obtained, or more than $8,600 per ton—drawn wire, largely used in the construction of piano and other musical and mechanical instruments. Among these specimens also was pinion wire, at a market price of $21.60 per pound, or $43,200 per ton—it took 754 hairsprings to weigh an ounce of 437½ grains; 27,000,000 of these were required to make a ton, and, taking one to be worth a cent and a half, the value of a ton of these cheap little things ran up to over $400,000. The barbed instrument used by dentists for extracting nerves from teeth was even more expensive, representing some $2,150,000 per ton.

There is at the present moment a very interesting system of electric tramways being constructed at Genoa, Italy, by the Allgemeine. Genoa is built on the side of a hill, and, to overcome the sharp gradients existing, several spiral tunnels have had to be pierced in the hillside, through which the electrical cars rise from one level to the other. The system inside the town will, when built, aggregate some thirty miles of track. Besides the town lines, lines are being built from Genoa to Nervi, Genoa to Voltri, and Genoa to Pontedecimo. The aggregate of these latter lines will be some forty miles, and alternating transformer substations will be used, somewhat similar to the system now running in Dublin. The current for running these tramways will be brought from a lighting station now in course of erection, and which will aggregate some 12,000 horse power when completed. The line in Genoa, which was originally equipped by Siemens, has now been re-equipped by the Allgemeine. The engines were built by a firm in Legnano. The total number of cars running, when the system is completed, will be some 200.

There are no exact figures obtainable in the United States as to the mileage and work of the railway telegraphs, but in England the compactness of the country and relative fewness of the railroad companies allow some authentic data to be procured. It appears that the mileage of wire there employed for railway purposes has risen from 27,204 miles in 1869 to 99,296 in 1894. The number of instruments has risen from 10,121 in 1869 to 130,339 in 1894. The advances in block signaling in the railway service are known to everybody, and England in this respect is a praiseworthy leader. She still lingers, however, in her adoption of the telephone for railroad work, probably because of the absence of a record of what is said and done. In the matter of line construction, it is said that of late double pole lines have been resorted to, the cross arms constituting the bar of a letter H. This gives great stability, as well as increased capacity for wires. One of the foremost electricians in America has already advocated a like construction, on the ground that it would give a permanent value to property now destroyed in every heavy gale, and would thus convert a spiderweb of wires into a wireway as solid as a railroad track, and just as accessible.

MISCELLANEOUS NOTES.

The paper for printing Bank of England notes is dampened with water in the exhausted receiver of an air pump. The ink used in the plate printing is made of Frankfort black, which is composed of the charcoal of the tendrils and husks of the German grape, ground with linseed oil. The ink has a peculiar and deep shade of black, common black inks being tinted either with blue or brown.

Rainbow effects on cloth are usually produced by the use of sectional warps of multicolored threads, which threads in the loom lie side by side in groups of three or more, and the filling employed is as light as possible. After weaving, the piece is passed through a calender with fluted bowls, the grooves of which run in the same direction as the warp travels, each groove holding a group of the different colored threads. This arrangement gives the surface of the cloth a "waved" appearance.

There is one thing which users of the new high velocity rifles of 0·30 caliber have to consider, and that is the effect of the copper or nickel jacket on the grooves of the rifle. A bullet that leaves the muzzle of a rifle at a velocity of 2,000 ft. a second is so wearing on the rifling, especially near the muzzle, that the accuracy of even the hardest bored rifles is seriously impaired inside of 12,000 shots at the most. The lead bullets, or those but slightly hardened with a mixture of tin, do not wear the barrels to the same extent, and the barrels last far longer.

In his thirteenth report the English Comptroller General of Patents states that in 1895, for the first time since 1885, the number of applications for patents shows no increase upon that of the preceding year, but, on the contrary, a decrease of 331, the figure for 1895 being 25,005, only some 12,500 patents being actually granted. I may mention that 2·3 per cent. of the total applications were made by women. The balance sheet of the Patent Office is a very satisfactory one from the point of view of economical and honest administration. The receipts for 1895 amounted to £187,000 and the expenditure to a little over £100,000, leaving a surplus available for the revenue of over £86,000. The two principal items were salaries, £54,853, and printing, £24,650. A sum of over £100,000 was spent on new buildings.

All records of long-winded litigation appear to be broken by some German litigants. The story is as follows: On June 21, 1596, the peasant people of Burgsinn, a small Franconian hamlet in Bavaria, brought suit at the court of Speyer against the Barons Von Thuegen for the possession of a certain body of oak and beech land, which they claimed as their own. For 300 years, generation after generation of these poor people have managed to scrape together enough money to carry on this suit against the powerful barons, and a final decree was rendered in their favor, which went into effect June 20, 1896, just 300 years after the suit was begun. The tract of land is valued at $500,000. The inhabitants of Burgsinn had a big celebration on June 21, in commemoration of the tercentenary of their lawsuit.

The Diamond Match Company, on April 7 last, made a world's record on production in their factory in Barberton, Ohio, says the American Woodworker. On that date they produced 12,356 gross of boxes of matches, which means 1,779,264 boxes, and 100 matches are in each box, making the day's output 177,926,400 matches. At that rate that factory can produce in a year 64,943,136,000 matches, which means 927 matches a year, or nearly three matches a day, for each one of the 70,000,000 inhabitants of the country. All this work is done by automatic machinery that is without its equal in the world. This work was done by 340 workmen and 13 "continuous match making machines." The largest match sactory in Great Britain employs 8,000 workmen, but they cannot equal the output of the 340 workmen in the Barberton mill. The comparison is instructive all round. The machines used by this company have added $125 to every share of their capital stock.

Germany leads the list of beer-producing countries, according to the trade report for 1893, just published, with 1,202,132,074 gallons, an increase of over 34,000,000 gallons over 1892; 33⅓ gallons a head was the average for the empire, the product ranging from 62 gallons in Bavaria to 12 in Elsass-Lothringen. Great Britain was a good second with 1,164,752,952 gallons of malt liquor, over 30 gallons a head. America (including South America) came next with 1,084,433,460 gallons, 16 gallons per head. Then comes Austria with 385,256,168 gallons; Belgium, with 209,856,174; France, with 196,630,500 gallons; Russia, with 98,638,892 gallons; Denmark brewed 45,000,000 gallons, Holland 33,000,000, Sweden 28 and a third million, Switzerland 26 and a sixth million gallons. The other countries for which statistics are given all produced less than 20,000,000 gallons apiece. The total output of malt liquors in Europe and America was 4,500,000,000 gallons, in making which 7,270,000 tons of malt and 82,000 tons of hops were used.

The shop floor is a sort of a perennial subject that comes up at all sorts of regular and irregular intervals, and may be considered as always alive. I was struck once by the difference in the apparent activity of two sets of men working on similar jobs at the vise in two rooms of a large shop. One was in an old building and the other in one of recent construction. In the former the men stood easily and naturally at their work, and showed no symptoms of a hankering for a seat on the bench, while in the latter, the men were shifting their weight from one foot to the other, throwing one leg upon the bench at every opportunity, and showing every evidence of foot fatigue. It was noticed by the superintendent and occurred to him that it was due to the floors upon which the two gangs of men were standing. In the old shop the floor was of wood, springy to a certain extent, and a poor conductor of heat. In the new shop it was of the most beautiful concrete, an excellent conductor of heat from the feet of the workmen, and as unyielding as the granite rock in the neighboring hills. So the benches in the new shop were raised a couple of inches, and each man was given a platform of wood that rested on two cross pieces at the end, and which was slightly springy. The foot-weariness disappeared almost at once, and no further trouble was ever experienced. Which goes to show that the most comely floor to look upon is not always the best for the workmen.—J. H. Allen, in Dixie.

EXPOSITION OF THE GERMAN COLONIES, AT BERLIN.

IN arranging the exhibition grounds at Berlin, the aborigines were given a place by themselves, on a lake where they could live in their own way, so that their characteristic buildings are being placed in suitable surroundings. Those from Kamerun have their own village, those from Togoland have several houses, and buildings characteristic of Kaiser Wilhelm's Land have been collected into a village, which has been named "Tarawai," for the natives of New Guinea or Papua. These buildings, lying on the edge of the water, with their rambling gables, colored matting and covering of palm leaves, make a most effective picture. A structure built on piles in the water is devoted to the feasts of the men—no woman being allowed to enter it—and a large assembly house near by, from Muschu, in Kaiser Wilhelm's Land, represent the highest type of Papuan architecture. When we consider that such a house must stand very severe storms and that it was made of stone by savages with only their primitive tools, a respect for their skill is aroused, for part of the inhabitants under the protection of the New Guinea Company are now living in the stone age, although iron has made a triumphal entry where the European has gone. A remarkable wooden figure stands before one of the huts, an image of some god, and although the object of this grotesque figure of a man is not quite clear, we feel sure that it has some connection with the worship of ancestors. The Papuans are also skillful ship builders, and with their light boats provided with bowsprits they go far out to sea, and their relatives, the Polynesians, have invented a system of sea charts for their long voyages. The Papuans who have come to the Exposition are well developed men, not remarkably strong, who have come from the Gazelle Peninsula, on New Mecklenburg, and are good types of their race. They speak English, and some who are pupils of the mission know how to write.

Near the village of Tarawai there is a gloomy palisade, which is decorated with human skulls and provided with a bastion. It is a copy of the Quikuru qua Sike, near Tabora. From the African's point of view, this was a very strong fortress. The palisades were provided with gun holes and strengthened with wickerwork and clay; the entrances were restricted by the palisades and were covered by guns placed high up inside of the palisade. But when this palisade was once passed the invader came upon several circles of tembes, low, flat houses, which were very well suited for purposes of defense. In the center of this fortification now stands the dwelling house of the chief, who there hides his treasure in powder and ivory. Several unsuccessful attempts were made to storm the Quikuru before it was taken. The natives took shelter in the tembes during the night and on rainy days, but they spent the days in their villages, where they busied themselves with all kinds of work and dancing. The principal tribes represented in the Quikuru are the East Africans, Swahilis, and Massais, of whom the latter constitute one of the most interesting races in Africa. They have very little of the real negro in their appearance; they are slender, usually of medium height and are not muscular. Their chins are prominent and pointed, the lips thin, the noses not as broad as that of the true negro, the eyes are remarkably long and horizontal. They are cattle breeders, brave, bold, rapacious and often dangerous to the people of the coast who go through their country buying ivory. In his fantastic dress the Massai warrior rushes along with great leaps—he can run incredibly fast—his painted shield in his left hand and his spear in his right hand, and woe to the caravan that allows itself to be surprised by a band of such warriors. But now their strength seems to be somewhat broken by the cattle pest, which, during the last few years, has ruined their herds on the steppes, and they have had to endure a terrible famine. The young, unmarried girls are very attractive, but as women they seem to shrink and with their barbaric ornaments of pearls,

MASSAI WARRIOR.

and iron and copper wire—unfortunately the characteristic ornament, the iron collar, has been dispensed with by the women at the Exposition—are most unattractive. It can easily be imagined that this part of the Colonial Exposition is much visited, for heretofore no Massaians nor Papuans—with the exception of two of the latter—have been to Germany.—Illustrirte Zeitung.

$250 PRIZE ESSAY COMPETITION—THE PROGRESS OF INVENTION DURING THE PAST FIFTY YEARS.

Fourth Prize, won by (SEMPER FIDELIS) GARDNER D. HISCOX.

THE genius of invention during the past half century has accumulated a record in the United States alone of more than half a million patents, which testify to its progress and its glory by the developed results in our national advance in mechanical science and practice, as shown by its industries and the vast accumulation of wealth derived from the application of inventional devices in manufacturing and commercial lines of business.

The contributions of inventions to the welfare of the nation during this period has shown a marked stage of progress, incomparable with any world's record of past centuries.

While our popnlation has increased, within the past half century, about three and a half fold, the number of patents issued has been thirty-eightfold over the total number issued during the half century previous to 1846.

From 1846, in which year but 638 patents, out of 1,272 applications, were issued, the increase has made a rapid stride, rising in annual numbers to 26,292 in 1890, its culminating year.

The inventive progress through this period cannot be said to be represented by the number of patents issued, for the number of applications really represents the activity of inventive minds, as shown in a comparison of the disparity between the number of applications and the issues.

The issues of the various years of the period are found to vary from 45 to 65 per cent. of the applications; the total number of applications and caveats for the half century, amounting to upward of one million, should represent the thrift of inventive genius and its wide field of working among our people.

The merits of but a few leading inventions only can be treated of in a short essay, and those only that by their widespread application and usefulness have largely influenced and contributed to our national prosperity.

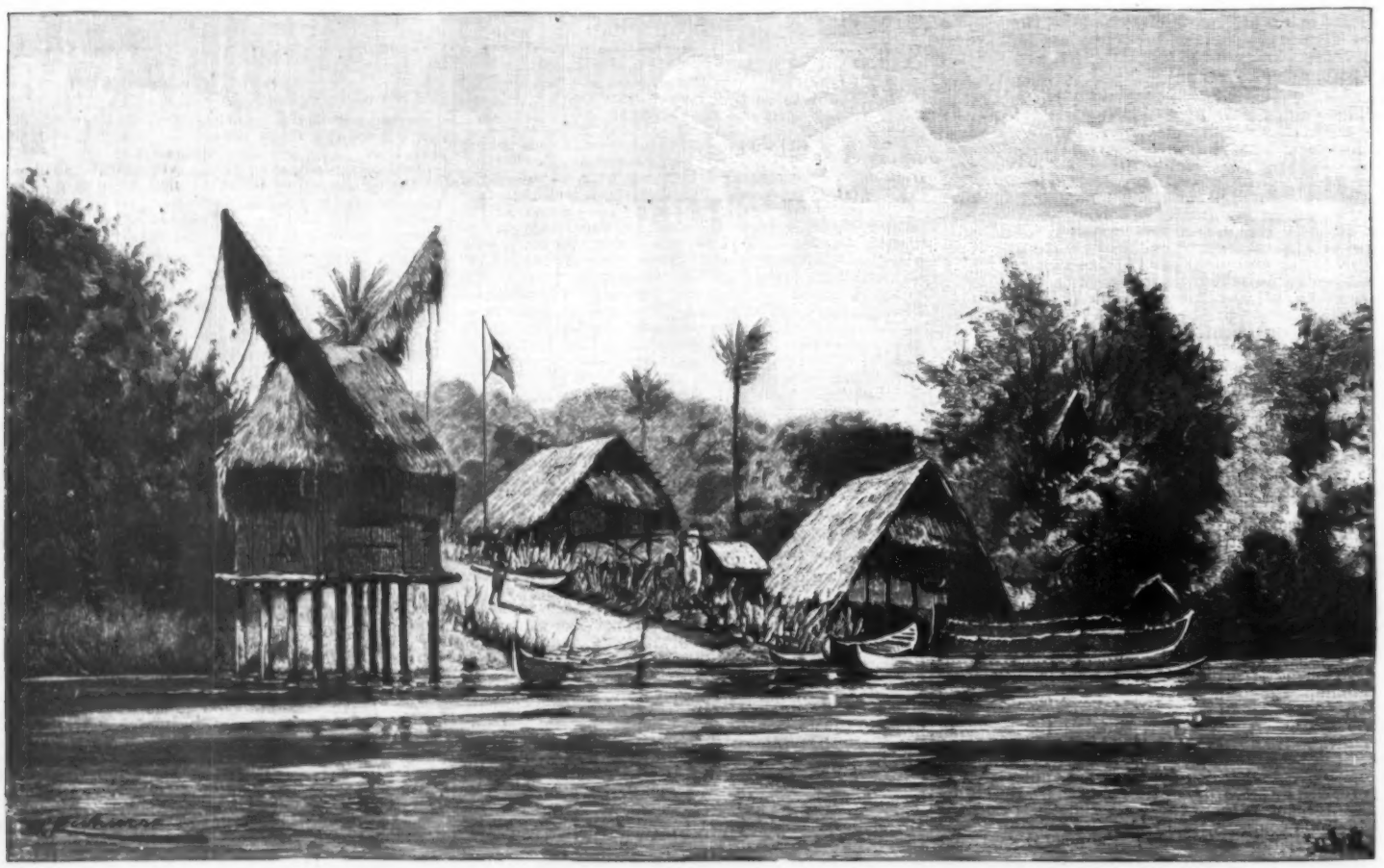
The class of inventions standing in the front line of merit, and forming the base of vast industries and wealth, is probably that relating to the manufacture of iron and steel and their application to the leading industries of our country.

The inventions in the later processes of steel making, dating from 1856, of Bessemer, Siemens, Martin, Kelly, Holly, Reise, Redemer, Tilford and others, have given to the world a perfect steel for all purposes, with an expansion of its manufacture in the United States, from a beginning in 1865, to an extent that has supplied the best material, both iron and steel, at the lowest price for the vast expansion of our railway system, and which by the aid of the genius of invention in the manufacture of rails alone has reduced their cost many fold, or from $120 per ton in 1872 to $25 per ton in the past year.

The first steel rails were made in 1865, reaching the enormous annual output of two million tons in 1890, and by the increasing facility for cheapening the cost of rails and structural work, has been a leading factor in the vast increase of our railway mileage.

The inventions appertaining to locomotive and train service have reduced the cost of transportation with increased speed nearly twofold, and thus the means of cheap and quick transportation has been made one of the prime factors in the progress and thrift of the people of the United States.

The inventions and improvements in the detail of mo-



TARAWAI, SEEN FROM KARPFENTEICH.—DRAWING BY VON W. KUHNERT.

tive power, protected by many thousand patents, have largely contributed to our rapid progress in manufactures and commercial intercourse by developing economy in the use of power, and by this means has stimulated manufactures in every line to a successful competition with the cheaper hand labor of foreign countries.

The great servitor of motive power, the steam engine, has advanced from its simple form of valve movement and ball governor, in 1846, through the inventive efforts of Corliss, Reynolds, and a host of improvers, to its present and almost perfect action and magnificent dimensions. It is credited with nearly 11,000 patents and 6,000 more to the generators of steam.

Hydraulic motors have advanced to the front rank of perfection in the impact wheel, with 2,500 patents to its credit.

The heating of public and private buildings and factories by steam, originated in 1847 by the late James J. Walworth, and rapidly expanded under the fostering influence of patent protection to the universal system of steam heating now in use.

The stride in architectural construction in its present skyward aspect can scarcely be said to have a history, so recent is its plunge upward. Steel and the appliances of construction, due to the inventive progress of this age, have supplied the structural elements, and in this way accomplished the desire for its skyward progress.

The rapid advance in perfecting the construction and operation of passenger elevators, protected by more than 1,500 patents, was first started in 1857 by Elisha G. Otis, followed by Tufts, Whittier and others with steam elevators; changing in a few years to the hydraulic form, and lastly to the electric motor, has made a relief from labor appreciated by millions of people in the ease and comfort of reaching our high business and residential perches.

In marine engineering the progress of invention has been most marked; the change in the material of ship building by the introduction of steel has been the means of developing a wonderful progress in the size and perfection of proportions in our naval and commercial marine. The economy of power and great speed acquired by increased steam pressure and the multiple compounding of marine engines largely owes its recent and wonderful progress to the inventors' resources.

The possibility of twenty-five miles per hour in a seagoing steamer would have been a crazy dream in 1846, when the Atlantic steamers required twelve days for a passage, falling to eight days in 1870 and to less than six and a half days at the present time.

Among our swift river craft but little progress has been made in speed; twenty-two miles per hour was attained in 1849, and scarcely better can be had to-day.

In the power of warfare the genius of invention has evolved conditions of offense and defense by the use of steel to such a degree as to almost eradicate from existence the old war vessels and material. Steel breechloading guns of immense power, steel shot, steel protective armor and new forms of rapid firearms are the output derived from thousands of patented inventions that have contributed to the present state of advancement in the art of war, there being over 3,500 patents on ordnance, projectiles and explosives alone. Gun cotton was discovered by Schonbein in 1846, and has become the basis of the rapid advance in the power of explosives.

The age of steel, as this period may properly be called, has made by inventive influence a vast stride, not only in the manufacture of warlike material, but also in the design and construction of the tools for accomplishing such large work. The record of inventive progress in labor saving tools and machinery being a most noted one, for in metallurgical methods, appliances, machinery and mills there is a credit of over 33,000 patents for the half centennial period. The steam hammer, first put in operation by Nasmith, in 1838, in a small way, now wields a power of four thousand foot tons to a blow, a giant in constructive work.

A new power competitor to the steam engine as a prime mover has had its practical birth entirely within the past half century. The gas and oil vapor engine has quickly expanded from a mere toy at the start to the front in power and dimensions and is rapidly expanding its usefulness for all wants of small and intermediate power. It has a quality of safety not in the sphere of steam power that is appreciated by all users. Its inventive history is short—scarcely older than thirty years—but makes a full volume, with a thousand protective patents. It has come to stay.

Coming to the sphere of the helpers to feed mankind, the implements of agriculture claim a large share in the progress of invention. The plow, mower, reaper and the steam plow, with thousands of minor inventions and improvements in agricultural implements, amply attest their great value by their facility of operation in the production of the vast agricultural output of our country.

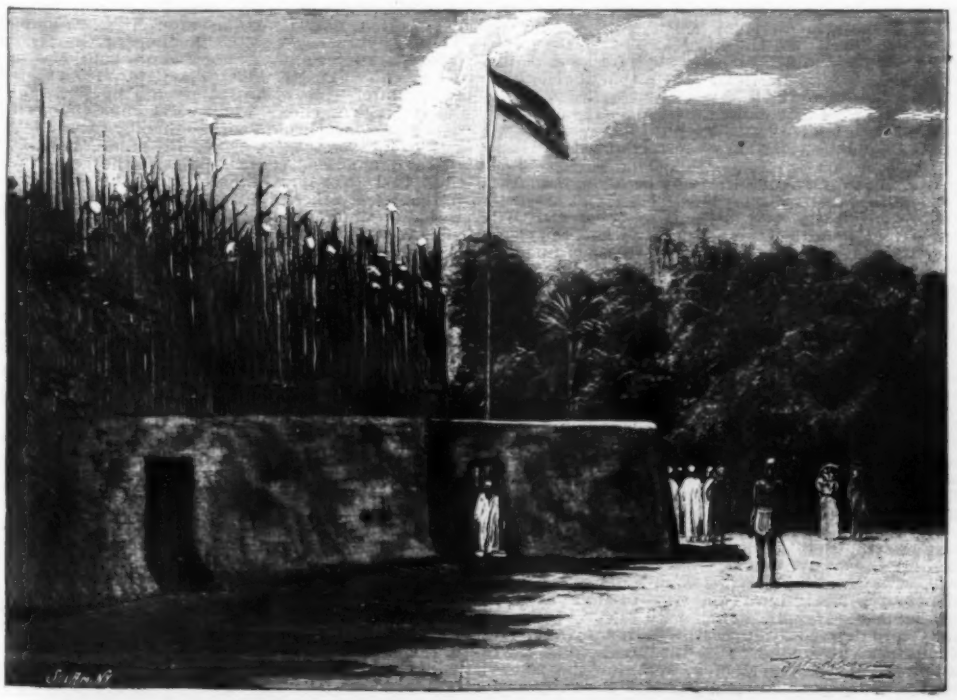
Reapers and mowers, although the subjects of a few patents and trials of past times, seem to have taken no practical shape until about 1845, when the McCormick reaper started a progress in crop gathering machinery that has become a saving element in harvesting our

MASSAI WOMAN.

vast cereal products. The present value of agricultural implements and machinery in use in the United States is estimated at $550,000,000 as against $150,000,000 in 1846; while the total value of farms, stock and machinery is estimated at $17,000,000,000, as against $3,000,000,000 in 1846; a vast value for Uncle Sam's farm, which is largely due to the economical working effect derived from the 55,000 patents granted for agricultural implements and appliances during the past fifty years, as against a total of 2,000 patents granted during the previous half century.

The present estimated value of machinery of all kinds in the United States is $1,600,000,000, and its annual products at $10,000,000,000, while the total value of properties of all kinds has reached the enormous amount of $70,000,000,000, largely through the influence of the energy of invention and progress in business development, which represents no less an inventive progress by its want of patent protection.

The production of artificial refrigeration and the manufacture of ice had its birth only 21 years since (1875). It has become a fixed institution and indispensable for the preservation of perishable food, as well as a boon to the people of tropical climates. Its lines of inventive progress have been sharp and conclusive with the numerous elements that have had their trials, such as ether, sulphurous oxide, bisulphide of carbon, compressed air and ammonia, of which the last named seems to have made a successful lead for all purposes of refrigeration. Its protective exhibit numbers over 3,000 patents.



QUIKURU QUA SIKE.—DRAWING BY VON W. KUHNERT.

The printing press, by the aid of the inventive efforts of Richard M. Hoe, Stephen D. Tucker, Campbell and others, has attained a perfection of action and speed little dreamed of in 1846, when 3,000 eight page sheets per hour was its best work.

The patents for its leading improvements were issued to R. M. Hoe in 1847; then steam power coming to the rescue, together with the revolving type cylinder of 1849, largely increased the capacity of the printing press. Its improvement has been steady and constant, so that the great octupal printing press of to-day turns out 96,000 eight-page sheets per hour, folded and counted for delivery. It has nearly 6,000 patents credited as a foster mother to the rapid advance of improvement in the machinery and art of printing. Its value to our country in disseminating knowledge and in the promotion of business and commerce cannot be estimated within a reasonable limit. Its improvements have extended methods and speed of power printing to every department of the printing art. lithography, color printing in the finest art work, bank note work, and in book and newspaper work, it has made a progress undreamed of in 1846.

The sewing machine, the great contributor to the industry of the needle, although known in an experimental way for a century past, was only patented as a practical machine in 1846 by Elias Howe, who was rapidly followed by Singer, Wilson, Grover, Gibbs and others, in perfecting its design, and now it has become a giant in needle work for all purposes. It has had its immense expansion of usefulness within the past forty years, now having to its credit more than 6,000 patents.

India rubber has become an indispensable material for mechanical use and human comfort; it only dates its first manufacturing invention from Goodyear's experiments in 1838, and which began to receive attention in 1846, from which time the manufacture of rubber goods has expanded rapidly, reaching every avenue of mechanical and human use, protected by more than a thousand patents.

The invention and use of celluloid dates only from 1869, with many patents to Hyatt and others. It has advanced to an important place among our trade articles, largely taking the place of ivory.

The diamond drill, so useful in prospecting the solid earth to great depths, and so essential to mine development, only dates back to 1864. Its leading features are the subjects of many patents.

The use of electricity for communication, power, light and for its many applications as a chemical reagent, and as bringing the reduction of aluminum to a price that warrants its common use as a metal and an alloy, was as a mere toy element in 1846, with its intensity urged only by battery and frictional effort. It has been rapidly expanded in power and usefulness by the persistent efforts of inventive genius, in transforming the conditions for creating its marvelous energy to the vast extent that it is now used in the needs and pleasures of human existence; that of all the appliances for the promotion of the business and the comfort of life, it stands near the head line with more than 17,000 patents to its protective credit.

Of its various divisions, its inventive progress is credited with 3,000 patents for telegraphy, and 2,300 for telephony. The present value of these inventions cannot be estimated; they have become an essential part of our everyday life.

The telegraph taking its start from the expermental line of Prof. Morse, in 1844, has concentrated the business capacity of our country a thousandfold. Its work now covers a million miles of line and transmits 60,000,000 messages per annum. One of its latest feats was to send a message over land and under sea in a continuous route of 27,500 miles in 47½ minutes.

Its close companion, the telephone, starting into practical existence only twenty years ago, having its progress hampered by a fundamental patent, has nevertheless been the subject of more than a thousand patents and finally emerged from its bond with enormous wealth to its bondmen. Its saving in business facilities ranks its value high in millions to the business community; it having over 600,000 miles of line and more than 700,000 telephones, furnishing 670,000,000 conversations in the past year.

In submarine communication, after many trials, the first telegraphic line was laid across the English channel in 1850; and the first successful line across the Atlantic was not completed until 1867, as a result of severe inventive effort.

Electric lighting dates no further back than 1879, in the hands of Brush and Edison, and by whose activity the latter has accumulated over 700 patents for electrical inventions.

The electric railway only dates from 1881 in a patent to Edison, although the principle of electric propulsion had been a toy for many years.

The photographic art, emerging from its experimental stage in 1840, made but slow progress for many years, until by the change to the collodion process in 1851, it had a gradual advance and may date its real progress from about 1856, since which time its expansion in perfection and usefulness has been rapid in its capacity for producing a perfect record of the most intricate details of nature and art; and with its application to and its assumption of the engraver's art, has greatly enlarged the resources for multiplying the record of mechanical, architectural and art work.

It has at last by the use of the unknown element in the electric light made a marked progress in making visible the hitherto hidden details of living anatomy. The fostering protection to discovery and invention of the ways and means of the photographic art has a half century record of 1,500 patents.

One of the newer offsprings of the genius of invention is that wonderful handhelper, the typewriting machine—the business man's right hand. After a few preliminary efforts, starting with one patent in 1843, but not springing into practical existence until about 1856, when, in the hands of Alfred E. Beach, a practical result was obtained. Improving slowly, it seems to have taken a better form in the hands of Soule and Scholes in 1873, making rapid progress in the hands of many inventors, it now stands in the front line of useful inventions, an indispensable adjunct of business life; numbering near a half million machines, and

showing an inventive progress protected by more than a thousand patents.

The wild race of invention seems never to have been so intense in any line as in the development during the past decade of what has become the recent craze, the bicycle. Its practical birth cannot date further back than 1862, when crank-driven tricycles for children had taken a permanent start and the old tip-toed bicycle of a past century had dropped out of use. The high-wheel bicycle came into use about 1876, making slow progress in improvement during a decade, when the present form of geared wheels started an advance that has been a marvel of inventive progress during the past decade, creating an industry involving many millions in capital, with its interest protected by no less than 2,500 patents.

In a retrospect of the early years of the past half century, when we jogged over the rough cobblestone streets in an omnibus, the horse car and tramway came as a thing of comfort and speed in city travel. A few lines of steam railways between the larger cities were expanding into importance, but the great waterways held the sway for transporting mankind and his products, our swift river steamers being a delight to the traveler and the great canals at the head as a means of transportation.

Our people counted but twenty millions, occupying less than one half of the territory of the United States, but the spirit of improvement and progress was wide-awake to the means for supplying our increasing needs and wants. The genius of invention was emerging from its ancient lethargy, to behold the glorious dawn of an age of steel, wherein by the light and glory of an inventive progress, a vast stride was to be made in the growth of civilization and wealth of a nation of freemen.

New elements were to come into use; economy in developing power and in manufacturing the vast volume of goods for the needs of our increasing millions; new ways and means of transportation and communication; new facilities for the transaction of business; a vast credit to be established by universal industry; a national progress and growth to be brought about in a single half century, unknown in the history of the world, was a dream that has been realized.

WOOD ENGRAVING AS COMPARED WITH OTHER REPRODUCTIVE ARTS, AND ITS FUTURE AS A FINE ART.*

By W. Biscombe Gardner.

In the short paper I am about to read, I wish to place before you—first, the many advantages wood engraving possesses over all other reproductive arts; secondly, what I think ought to, and what I think will, be the future fields of this art; and, thirdly, to follow up with a suggestion as to a way to arrive at that result. Whether my suggestion will be taken up I must leave the future to determine.

The great power wood engraving possesses beyond all other reproductive materials, I hope to prove, by bringing before your notice the variety of methods of handling the graver which has been resorted to in the production of the specimens that are on view to-night.

Wood engraving, we are told by some people, is dying out, or will be one of the past arts before many years, and process or mechanical work by means of photography will take its place as a medium for illustrating books, magazines, and papers.

This is what we hear on all sides, and if we look at the illustrations at present produced in most of the publications, it undoubtedly does appear at the first glance as if there were something in this almost universal opinion. But what is this so-called popular opinion? I think it only comes from readers who confine themselves to the sensational side of literature, and not having their imaginations fully developed, want something beyond the letter press to help them to realize what they are reading; then cheap art comes in to help the cheap publications, which are on the increase to such an extent that process illustration looks as if it were taking everything before it.

But, by dipping a little deeper into the question, we find a very different state of things. We see that wood engraving was never more alive as a fine art, or in a higher state of perfection, than it is at the present period; and it is still capable, in the hands of right good earnest workers, of being lifted to a much higher position.

We may grant that wood engraving has been superseded for a time, for purposes of illustration, by process work, on account of the latter being so much more rapid, and also much—very much—cheaper. I will not say very much inferior, for it is unquestionably better than bad wood engraving. And here I may say I do not mean essentially bad work, but work that has to be done in a rush, such as war subjects, which sometimes have to be engraved in a few hours.

Yet, so long as the public are blind enough (blindness which makes one wonder, considering the art culture that is going on all over the country) to take bad, or rather, as some put it, "soft and delicate" kinds of illustration, instead of good art, both delicate and beautiful, so long will some publishers give them bad rather than good work, charge the same for the publication and pocket the difference; and why not, if the public will be so foolish? Every opportunity is afforded them to distinguish the good from the bad; but they, or the majority of them, judging from the publications that pay best, prefer the bad to the good. Then what happens? So long as this blindness or apathy lasts, so long will wood engraving suffer in this particular department of publication.

But we have a much brighter side to look at. Let us leave behind the lovers of cheapness and speak to those who are lovers of art for art's sake. To them I say that wood engraving, as a reproductive fine art, never can be touched or ever will be touched by any process yet invented. I am now speaking of all the mechanical processes at present being used for illustration. With regard to the higher or fine art processes, I hope to show further on that wood engraving is far and away above any of them in its marvelous versatility of technique, which enables the engraver to translate not only the values but the very individual touch of each artist from whose picture he may be engraving.

All processes dependent upon photography are bound to go wrong in the rendering of values, since photography has not yet been brought to such a state of perfection as to master the difficulties of exact color translation. In fact, photography is utterly inadequate in the most simple wash drawings in black and white. For instance, a drawing executed in black, no matter what black, when Chinese white is used mixed with the black, will come out, as a whole, entirely untrue as to values in the process block, because of the brown in the black and the blue in the white. The slightest difference in the admixture of the two colors will be entirely mistranslated, although the drawing may look perfectly right as to the values to the eye.

Even in a pure wash drawing, without the use of Chinese white, the paper drawn upon being more or less yellow, the high lights that are left are lower in tone in consequence.

Take any process, and if you have an intimate knowledge of the original painting or drawing from which the process plate has been done, you will see at once how very far short it falls of the original. All the spirit has departed from it—it is weak and insipid. Indeed, although photography has made great strides in late years, it has not yet been able to get over its main difficulty, values, and I must say that I do not see at present how it can get over it. No process plate that I have ever seen, either from a painting or a black and white wash drawing, has had a pure black or a properly gradated white, which is as much to say, it cannot carry out the most simple rules of translation of values. But, I admit with pleasure, that a pen-and-ink drawing in pure black ink could hardly be reproduced in a better manner than by the best process. I say the best, as I only now and again see a very fine line reproduced thoroughly well by process. As a rule, it is either broken or thicker than the original, and thus loses its value. But beyond this, I most emphatically assert that nothing does or ever can compare with the work done through the sensitive medium of the eye and hand of man. In fact, I consider wood engraving far better than any or all the reproductive arts, as it stands quite alone in its wonderful adaptability; for any variety of texture one likes can be produced on the boxwood block. This cannot be said for either etching, mezzo-tint, steel, or copper, each having its own methods, great as the masters have been who have worked upon one or the other of these materials; and, as far as I have seen, they never have departed from the original mode of treatment, peculiar to the material they worked upon. Thus they have necessarily missed the individuality of the painter they translated. The reason, of course, being that the material will not lend itself to variety of treatment.

Now, with regard to wood engraving on boxwood, any texture you like can be engraved upon this material, it is so adaptable. But it requires an artistic engraver, not a mechanic, to arrive at anything like good results. Happily, at the present time, we have plenty of right good artistic engravers, not only here in London, but all over the world.

The crowning advantage enjoyed by wood engraving, through which it obtains its immense superiority over all other methods, is that the engraver is enabled to work in both black and white line. This, in the hands of an artistic engraver, one who knows his work, and, beyond that, loves it, is a most valuable power.

Nothing is out of the range of imitation possible to wood engraving. The differences of textures of flesh, silk, satin, cloth, wool, steel, glass, the grain of wood, marble, weather worn stone, furs and skins of animals, atmospheric effects, foliage of all kinds; all these it can represent, and beyond everything, it can render the differences between oil and water color, and can accurately transcribe the old master's work with all its cracks and blemishes from damp and shrinkage. It has been said by some that the old masters cannot be rendered in this way except by photography.

As an example of this peculiarity of wood, I would call attention to an engraving after Fra Angelico, lately used to illustrate a paper on "Angelico at San Marco," by Mr. Grant Allen, in the Pall Mall Magazine, a proof of which you will find upon the table. It represents the reception of Our Lord as a pilgrim by two Dominican monks in the garb of their order. The original is a somewhat damaged fresco, still occupying a lunette on the wall of the convent where it was first painted. I venture to think it will be seen on inspection that the engraving manages to reproduce the peculiar medium of fresco, the characteristics of the artist, the present state of his work, and the irregularities of the surface in a way that would be impossible with steel or copper, or any other medium. It, I think, completely answers the objection that wood engraving is incapable of giving the tone and manner of the old masters.

All things, I have said, are possible on wood; and this is secured by variation of line, admixture of dots, or round or lozenge shaped spots or strokes of the graver, cut in different directions across one another. In fact, one can hardly lay down hard and fast rules with regard to the exact methods to be used. All depends upon the subject to be engraved and the feeling which it engenders. This, again, depends upon the thoroughly artistic sensibility and training of the engraver. He must first be an artist, in feeling at least, well grounded in his anatomy, daily using his pencil or brush in drawing or painting; in fact, an art student. This is most essential—that is to say, if he wishes to do good work. Then he must be well up in all the branches of art. He must take a pleasure in his work and turn out his best. Such an engraver will not feel inclined to do what we call "manufactured engravings," but rather will feel a fresh delight in every subject that comes before him. No matter who the master may be from whose work he may be engraving, each one is a new study or problem. He has to reflect how he can best render that particular painter's feeling and individuality.

In order to illustrate or rather bring thoroughly home to you what wonderful qualities wood engraving has, far and away beyond other reproductive arts, I will, with your kind permission, now draw your attention to the few subjects on view to-night, each one having been carefully chosen with that object. But for you to thoroughly appreciate the points that follow, I must ask you to kindly note the numbers of the examples that I shall speak of, so that after the paper is read you may go round and examine the subjects for yourselves.

Take, for the first example, "A Study of a Head" (No. 1), after the late Lord Leighton, P.R.A., compare that with the portrait of George Meredith, the author, after the painting by Mr. G. F. Watts, R.A. (No. 2). Here you have two painters with entirely different methods of handling; and I think you will find, on comparing the two proofs, that the individual touch and characteristic handling of each painter has been preserved in the reproduction. These two examples, one would think, would be quite enough to convince any one; but I will follow on with others, showing of what variety of textures or changes in handling wood engraving is capable.

We have here on the table four engravings, after paintings by Mr. G. F. Watts, R.A., and if you place them side by side you will find the engraving has followed the changing or gradual development of this painter's peculiar technique. On comparing (No. 3) the "Late Lord Tennyson," painted about forty years ago, with (No. 4) "Little Red Riding Hood," painted somewhat later, you will notice that the handling is slightly changed, moving toward what is shown in the next example of much later date (No. 5), "Love and Death." In this subject notice especially the drapery of the Angel of Death, in which you will see Mr. Watts' more marked technique of the present day. This quality, I venture to think, is still more fully shown in the engraving (No. 2), "Mr. George Meredith," painted only three years back. Here you have Mr. Watts in his very marked personality, as it is at the present time.

Then, further, as to what can be done on wood, take (No. 6), "The Recording Angel," also after Watts. This was engraved from a very highly finished chalk drawing, and I believe, when you look at the proof from the wood block, the fact of the original medium will simply declare itself.

Next, I will call your attention to three engravings, after Mr. L. Alma Tadema, R.A., whose methods of painting are, as you all know, entirely distinct from those of the previous artists whose works I have just spoken of. The first engraving (No. 7) is from a water color drawing, entitled "The Old Story," and is exactly the same size as the original; and all here who are acquainted with Mr. Alma Tadema's work know he is bound to thoroughly delineate textures, no matter in what medium he may be working. Being the genius that he is, he simply cannot help himself. So, how could any engraver go wrong with such a master of technique to translate? Anyhow, you can presently judge for yourself by comparing the difference of texture in the engraving of the drapery and marble in No. 7.

In "Cleopatra" (No. 8), I would call your attention to the hangings on the barge compared with other parts of the engraving. Then (No. 9) an engraving that was executed many years back, and being almost the first attempt at textures on wood, I thought would not be a bad example to bring before you, not that the engraving can be called good, but that the attempt at the textures was not so far bad, and that your attention should be drawn to the fact that flesh, glass, woolen fabric, wood, paper and metal are here delineated. It is from a portrait of the late Prof. Amendola. The professor is in the act of working upon a statuette of Mrs. Alma Tadema, wrought in silver; the drapery is oxidized, and the flesh pure silver. I think you will see that the texture of the different materials is kept in the engraving. There are two or three other and smaller examples from Mr. Alma Tadema's work on the table which are not in frames.

Here I think it will be appropriate to mention two of Mrs. Alma Tadema's most delicate and beautiful works, of which I have proofs on view to-night, and ask you to look at them, not only as to the textures, but also to show how finished wood engraving can be; (No. 10) "Always Welcome;" (No. 11) "Well Employed." In both these examples, to thoroughly carry out the feeling of the originals, you will see that every use has been made of the great variety of manipulation that the worker has command of in wood engraving.

We will now notice a few more examples. (No. 12), "Portraits of Two Gentlemen," after Sir Joshua Reynolds, P.R.A.; (No. 13) "Miss Linley and her Brother," after the well-known picture by Thomas Gainsborough, R.A.; here you will see that a peculiar kind of texture has been brought into requisition to enhance the softness of the flesh lines; (No. 14) "Study of Old Woman," after Mr. James Sant, R.A.; (No. 15) "Study of Head," after Mr. Marcus Stone, R.A.; and (No. 16) "Graziella," after Mr. C. E. Perugini. The better to convey the handling of the last two artists, as simple a line as possible was made use of in both engravings. (No. 17) "The Return from the Fete Dieu," after the celebrated picture by Mr. Phil. R. Morris, A.R.A., shows what wood engraving can do from another style of handling in oil. (No. 18) "The Fairy Tale," after Mr. E. F. Brewtnall, R.W.S. In this several methods of manipulating the graver came in useful. (No. 19) "Fatima," after the same artist; in this, as in others, the texture of the curtain, which is slightly different from those previously mentioned, adds very much to the value of the materials of which the costume is composed. I would recommend your thorough examination of the proofs, as they will bring before you more vividly than words what a valuable agent wood engraving is as a reproductive art.

Now, as an example of the importance of the direction of line, I would instance the figures in the engraving (No. 20) after Sir E. Burne-Jones' "Wheel of Fortune." Notice here the way in which the line is made to curve upward or downward on the surface of the limbs, so as to give, not only the sense of relief or rotundity (the modeling of arm or thigh, or knee, or finger), but also the degree in which each part approaches to or recedes from the eye of the spectator. Many engravers often run their lines longitudinally, or in one direction only, over the head or limb, and rely upon varying thickness or closeness of line for the modeling or effects of light and shade. But, in my opinion, the best way, when possible, is for the engraver to make the lines follow and suggest the natural contour, bringing it delicately round at knee, elbow, or knuckle, so as to point out and accentuate the rotundity of the figure. It then accommodates itself both to the actual shape of the limb and to the nature of the perspective or foreshortening.

As specimens of wood engraving from water color, I will take two portraits by Prof. Herkomer, R.A., and am sorry I have no others to show you, but anyone can see for himself in the best magazines and illustrated

* Lecture before the Society of Arts.—From the Journal of the Society.

papers how beautifully wood engraving can render the transparent wash and crisp touch of this medium.

In the two specimens, "Prof. Ruskin" (No. 21), and "Mr. J. W. North, A.R.A." (No. 22), the technique in the originals is peculiarly Prof. Herkomer's own, so in these engravings you will see a slightly different kind of line has been made use of to render this medium, and more especially the handling of this artist.

Again, while on the question of line, look at the differences of touch used in the engraving of three portraits. "The Late Lord Tennyson" (No 23), "The Right Hon. W. E. Gladstone" (No. 24), and "Mr. W. J. Linton" (No. 25), the father of American wood engravers, but an Englishman for all that, and one of the grandest of our English wood engravers. In the first case, what I will call a trembling, or shaky line, has been resorted to, to give age to the flesh; in the second a cross hatched white line is used, so as not to detract from the principal black line which gives form; but the white line is so used by engraving it before the black line, and to a certain extent modeling the forms of the lighter parts, that it enhances the value of the markings of age in the flesh, without grinning, as it would if engraved at the end of the work which is so often done; and in the third, just a simple black line is made use of, which still gives the aged look, without rendering the markings too intense or conspicuous. In these three examples, observe how valuable is the use of both pure black and pure white line in rendering the hair. These three were engraved partly from photographs and partly from a personal knowledge of the originals themselves.

Then further, as to what wood can do, we will take three engravings from pencil drawings. The first (No. 26), "A Study," is engraved from one of those beautifully finished drawings by Sir E. Burne-Jones; the second (No. 27) is also from the same hand, but the study was on brown paper, which gives a different texture to the drawing, so that in the engraving you will see that an entirely different method of treatment has been resorted to to render this subtle difference. At the same time, it may interest you to know that this study was one of many for the picture of "King Cophetua and the Beggar Maid," and that Mr. Comyns Carr's son was the chosen model. The third (No. 28) is from a delicate drawing by Mr. E. F. Brewtnall, R.W.S., and in this, as in the others, I think you will find that the peculiar character of pencil work is retained in the engraving.

That these specimens somewhat demonstrate the wonderful versatility of wood engraving is to me absolutely conclusive; while as regards the means employed in producing any of the blocks here introduced, engravers, or lovers of engraving, ought to see at a glance how they are done, and what advantages wood possesses over other methods.

But will all wood engravers take the trouble to arrive at these results? I sometimes doubt it. So many of them, I am afraid, think too much of the money to be got out of their work, and will not sacrifice the time or give the thought requisite to arrive at what they know to be their best. "That is good enough" is sometimes, if not often, the quiet cry with some. They, perhaps, have not sufficient feeling or love for their art, grand as it is. "Publishers," they say, "will not pay more than a certain price; so why should I sacrifice myself for their sakes?" Hence the stereotyped cry, "That's good enough; it will pass the art editor." But publishers will pay for good work when they want it; I only wish, for the good of wood engravers, they wanted it a little more often.

Something has latterly been said about the public not appreciating good art in the publications—that they are indifferent; and on that account we are also told that the publishers are not to blame in the matter of the bad art produced in a number of the current magazines and papers.

Perhaps. But, as the artist or engraver is powerless, if the publisher will not take of his best, we must look to the public for the encouragement so much required. What the public insist upon having, the publisher will be bound to give, if he wishes to prosper. In fact, you see the very best plates in some publications are either etchings, wood engravings, or photogravure. This is done simply to keep well with the public, which shows that they like a good thing when they can get it.

A very large section of the public, I am glad to hear, are crying out for better illustrations, and are longing for more knowledge of illustrative art. Many publishers see that want, and, with a few exceptions, they take undue advantage of it. They give anything that will pass for the week or month, and, I have no doubt, judge from the rise or fall of their publications whether to give better art or leave bad alone.

Now, let us take each of the reproductive fine arts in turn, look into their different methods of work, see the results, and compare these with what I have previously shown that wood can produce. How very far short they are in reproducing the technique of the painter! To begin with, I will take etching, as it is the first and highest of those methods, though not one of the true reproductive arts.

Mr. Robert Macbeth, A.R.A., has done some most wonderful plates from paintings by the late Mr. Fred. Walker, A.R.A., and others. Yet, with all his great talent as an etcher, he can only give the subject and the values. You do not find the technique of the painter; you see instead Mr. Macbeth's marvelous manipulation of the needle. I look upon etching as a painter's art to delineate the feeling of the artist himself in that particular medium; in fact, an original art. Decidedly, in my way of thinking, it never was, and never could have been, thought of as simply an imitative art. The more you look into it, the more you recognize that every line conveys the feeling of the painter-etcher, not of the copyist. And yet, at the present period, etching is being used regularly as a reproductive art, and the public think they cannot have anything much better than a proof-etching of any well known picture; they do not see that the etcher can only convey to the eye a very general idea of the original. That is to say, this art gives you the subject—the true values of the picture—but what is wanting is the individuality or technique of the painter.

In a good etching from a picture we have the etcher, not the painter. We have a beautiful art, and yet, if I may be allowed to say so, one which misses the actual art in this particular department. As to the question, who is answerable for this misapplication of an art that is so personally interwoven with the fiber of the creative artist and not the copyist, I leave others to answer.

Next, take mezzotint. This is a delicately beautiful art, but I think what I have said about etching will apply in some ways to this also. It misses the one essential of a reproductive art—the power of preserving the individuality of the painter. We feel that want intensely in looking at the result. His touch is not there. It is the mezzotinter's, and his alone, that we find in the engraving.

Then again, take steel and copper. I cite them together as they are pure and simple line and dot work. Everything depends upon the beauty of the line, the true translation of the subject in the outline and values. Beyond that aim they fail utterly. As I said before the material on which they work does not lend itself to the handling or technique of the painter. To understand what I mean by this, take a picture full of impasto and another very smooth and highly finished. Both will, when engraved on steel or copper, come out equal in value. The impasto has gone, but the finish remains.

With regard to photogravure, this process does give you somewhat the handling and touch of the artist; but for the very reason that its foundation is due to photography, it does not come out quite true in its values.

I now approach the subject of the future of wood engraving and the likelihood of its permanence.

This I must say greatly depends upon the desire on the part of the public, or perhaps I should say, to their gradually being led up to a stronger wish for a better class of illustration or reproduction than they get at the present time. In fact, they ought now to get a far higher class of work given them considering the enormous profits made out of nearly every class of publication that is issued. But as it is they get cartloads of rubbish, and are as much as told that it is art and good enough for them.

I sometimes think that the British public must be greatly wanting in feeling for what is good in art, or otherwise they would not put up with so much that is given them. Anyhow, the question here comes to the front. How long will they go on putting up with this bad work? when they could have better if they would only strike for it, or insist strongly enough upon having it. If they would only do this, they would get the higher and more beautiful work, for the publisher would be bound to let them have their heart's desire. This would mean a higher class of work all round, and wood engraving would prosper accordingly.

But this is not all that wood engraving is destined to accomplish. It will be in the future, and not very distant future either, if worked by the engravers with their whole heart and strength, the leading reproductive fine art. I know there will be a big fight to go through, but what matters: I feel we must win.

I have only very faintly shown you what is being done at the present in methods of handling and with other methods added by earnest students; there is no end to what could be done with the material. It must come to the front. I do not say this idly or without a knowledge of what I see before me as to its capabilities beyond other reproductive arts; but all depends upon the earnestness of the engravers; they must throw themselves heart and soul into their work and be ready to make almost any sacrifice for it.

Then what encouragement there is in the fact that a strong taste for the beauty of the art is growing and manifesting itself in the eager way in which artists' proofs are being bought, not only in this country, but in America, France and I think Germany also.

This taste will naturally spread; it cannot help doing so; and I ask all wood engravers to work for this grand opening for the output of their work. I would advise the purchase of copyrights of good pictures, selecting subjects that would be likely to take with the public. Engrave and publish them in the same way that all other reproductive plates are published, that is to say, a limited number of artists' proofs with prints after letters at half the price to follow.

This would place upon the market a good and comparatively cheap art for the general public to indulge in; as the wood engraver could sell his artists' proofs at a lower rate than that at which the other fine art plates are published, simply because the printing would cost him less, and I feel confident that the public would largely respond.

If the engraver could not see his way to purchase the copyright, I would suggest a partnership between the artist and engraver, the engraver to put his work against the value of the artists' copyright, each to contribute an equal share toward the outlay for printing paper and other expenses necessary to the publication of a plate, and divide the profits. This would work to the benefit of both.

The wood engraver in this way would free himself to some extent and show what could be done independently of magazines or papers. Not that he would necessarily cut himself adrift from these sources of work, but would be helping himself onward to a higher line, in which he would not be so much ground down to help to build up the fortunes of others, as is too often the case at the present time; but thank goodness all publishers are not alike in that respect.

It has been said, and with truth, that the individual workers must die out—very true, and that fresh blood will be wanted to take the place of those defunct members of the art. I believe one way to accomplish this would be through the action of the Royal Academy of Arts, who are our pioneers in most of the fine arts. They should recognize wood engraving as a fine art, as well as steel and copper. They should elect members of this art as associates, as well as open their schools to students of the same under the same rules as those which apply to students of painting, sculpture and architecture, whose ultimate career might be that of the wood engraver. These students would then be able to have the good training both in drawing and painting, which knowledge is most essential to anyone wishing to be thoroughly able to reproduce engravings from the paintings of others. For the eye must be trained in feeling and color, as well as in drawing, if the engraver is to render with any approach to truth the relative values of any painting he may have to reproduce.

One sometimes wonders what becomes of all the Royal Academy students, of whom a very small proportion in the end come to the front. What happens to the remainder, who intended at least to try and make a great name? Perhaps it was that they were wanting in creative power. Then, if not painters, sculptors or architects, they would, perhaps, make first-rate engravers. And why? Simply because of the splendid training they would have gone through in the antique, life and painting schools.

Just think once more, if they only had had the chance of studying one or other of the reproductive arts at the same time that they were studying to be painters or sculptors, what a splendid band of workers in the reproductive arts we should have to go on with in the future. The cry of decay in this or that special art would not be heard; it would fade away to be repeated no more. These arts would revive in every way, and there would be a splendid future for them all.

I feel most strongly on this point, that it is to the members of the Royal Academy of Arts we must look to for some of the help that is required to prolong the life of this beautiful art. It ought not to be left to the dogged determination of this or that individual to force his art to the front without aid or encouragement.

These reforms would, I feel sure, open up one way to give the impetus to wood engraving that it now so much requires. The art would be more widely recognized as a fine art; a more general market would be opened up for the collections of fine art wood engraving plates, and the public would be enabled to get good art at a price they could readily afford.

It is principally to this fine art outlet that I look forward to as the great and future field for wood engraving.

THE MANUFACTURE OF FABRICS FOR TIRES.

UPON the evolution of a suitable fabric for pneumatic tires depended the perfection of the bicycle more than upon any other single feature. The merits of India rubber for confining the air and for affording elasticity were plain; the difficulty lay in securing the proper elements of strength. In the manufacture of the first pneumatic tires more attention was paid to methods of construction than to the quality of the fabrics. Besides, the test of time was needed to teach the tire makers the shortcomings of all the fabrics then obtainable. The preference was given to linen, on account of its supposed strength and durability, and cotton duck was also used, but both materials proved a source of disappointment, and, in some cases, a costly one.

"There was one firm," a member of the trade said lately to the writer, "who embarked early in the manufacture of bicycle tires under circumstances which promised to put them and keep them at the head of the trade, but they persisted in the use of cotton duck after its disadvantages had become plain to some of their competitors, with the result that their tire business is now comparatively unimportant. Another firm, just as they were beginning operations on a large scale, were solicited to try a certain grade of cotton goods. But they said: 'No; we have 150 or 200 cases of linen on the way from Europe, and that is good enough for us.' Later they probably regretted that the whole cargo had not sunk in the ocean, for even now they have hardly finished replacing the tires in which that linen was used."

Linen, by the way, is a most treacherous fabric, as was illustrated by the experience of a certain New York mercantile house. They once wrote to their agents abroad for some of the best linen to be had, without regard to price, to be made into shirts for a present to their larger customers. The linen which came was apparently of the best quality, but when it was made up and put into use it began to give way after the second washing. This is quoted in the trade as showing the unreliability of linen, even in the hands of experts. Its chief fault from the standpoint of the tire maker is its uneven strength, threads lying side by side in the same piece of cloth comparing as 3 to 10, whereas cotton fabrics are now produced with threads practically of uniform strength. Another drawback to the use of linen for tires was soon found to lie in the destructive effect upon it of the vulcanizing process—a trouble not experienced in the use of a good quality of cotton.

But cotton duck also had its limitations. The first trouble was that this fabric, as woven four or five years ago, was composed of longer threads in the warp than in the weft, or filling, in consequence of which the strain upon a tire in use fell wholly upon the weft threads, rendering the tire only one-half as strong as if the threads in both directions had been of equal length and equally subjected to pressure. To remedy this defect, weavers began to give the filling threads the same "crimp" as in the warp, so that both would have the same length in a piece of goods perfectly square. There were other objections to cotton duck, however. One was the liability of threads to break on account of the presence of dirt or foreign substances in the cotton, causing unevenness in spinning or weaving, and wherever there is a break in a pneumatic tire fabric, of even a single thread, the starting point of trouble may be looked for. In was also found to be desirable to have a fabric of greater tensile strength in proportion to the weight of the goods.

The solution of the problem as to materials was finally reached through the wide adoption of sea island cotton. This is a distinct variety, having a longer fiber than any other, which alone renders it stronger in proportion to weight than cotton of short fiber. It is claimed to possess superior strength apart from its longer fiber, and also to have greater strength when grown in certain districts. By means of careful selection of the raw cotton, combined with improved methods of manufacture, tire fabrics are now produced which have a strength, compared with ordinary duck of equal weight, indicated by the ratio of 105 to 50.

The treatment of the cotton by the fabric manufacturer begins with carding it, by which particles of the cotton plant, dirt, sand, etc., are removed, together with enough adherent lint to make the waste salable as paper stock at about $10 per ton. Next is the combing, to remove all fibers shorter than the standard of length desired by the manufacturer for the particular class of goods to be produced. The waste from this process is salable at about 4½ cents per pound, although the price paid for the whole bale may have been 17 or 18 cents per pound. There remains of the original weight of the bale perhaps not over 70 per cent. available for

use for the better tire trade—the longest fibers, from selected cotton, freed from impurities. Then by the repeated "drawing" and "doubling" of the "slivers" from cords, all the fibers which may be lying in a bent or crossed direction are placed parallel with each other, with the effect of reducing to a minimum any irregularity in weight or thickness. Thus are obtained the strongest yarns and the greatest possible uniformity in other respects. In a mill visited by the writer, where tire fabrics are produced, the continued combining of several slivers from the cards into one "end" is repeated until the number of "doublings" reaches nearly a million, before a single thread has been spun. Then comes the spinning, the last process of which is the twisting together of from two to seven strands into one thread, whence the designation of "two-ply" thread, "three-ply," etc.

The weaving of tire fabrics has given rise to very much study. The fabric man has been consulted assiduously by the tire manufacturer, and deserves a prominent place in the history of the development of this industry. It may be truly said that the initiative in the improvements which have been made have been due oftener to the weavers of fabrics and the designers of looms for this purpose than to definite demands from the tire trade for new and better things. It might naturally have been supposed that the making of tires would grow up in connection with the fabric looms. Indeed, some tires were manufactured in one cotton mill, but the proprietors soon concluded that it might be wiser to enter the market for supplying rubber men generally with fabrics than to antagonize all of them by dabbling in the use of rubber, and the latter was given up.

There is nothing else used in bicycle construction in such great variety as tire fabrics. A single firm are weaving or have woven 700 different grades of these goods. They are to-day supplying tire makers regularly with forty or more different grades—suited to heavy and light tires, single tube, inner tube, and detachable tires, woven straight or on the bias, from two ply thread up to seven ply, with "long center" or without, and with other variations to suit the special wants of inventors and experimenters. Many of the different weaves of fabrics are protected by patents, and other patents are now pending, which tend to keep the business for the present in few hands. What would be the result of litigation over these patents can only be conjectured. Lately the patentee of a widely advertised tire, the alleged novelty of which lay in the fabric, applied in the courts for an injunction against another manufacturer, preliminary to a suit for infringement, and, after arguments were heard on the question of novelty, the application was denied. In this case there is no use of a woven fabric, but the threads of the warp, so to speak, first imbedded in rubber, are wrapped about the tire diagonally over the threads of the weft, similarly covered with rubber and the whole is vulcanized.

The prime requisite of a tire fabric is that all the threads composing it shall be subjected in use to equal strains, and this involves the proper conformation of the tire to the wheel. This requirement has led to ingenious devices in connection with looms. The principal claim in the specifications for one patent for weaving a tire fabric reads: "The fabric is not only tubular"—as in the case of the ordinary woven hose—"but it is woven with one side of the tube much longer than the other side, so that the tubular fabric assumes a circular form corresponding to the wheel to which it is to be applied." There are advantages too technical to be detailed here, in a diagonal or bias construction of the tire, which may be attained either by weaving the fabric in this shape or by the method of applying the square weave. There are reasons, likewise not easily described in a brief space, why a tire which might run satisfactorily in a straight line might not withstand a sudden turn in the road, and scores and scores of other considerations will be pointed out by the fabric manufacturer to the intending producer of tires, all of which may not safely be ignored. But there is one point which does not admit of a difference of opinion—no treatment of fabrics, short of reinforcing them with solid substances, will render them proof against punctures.

No fear is felt in the trade of a falling off in the supply of sea island cotton. The production for the last crop year was reported at 90,000 bales (of 400 pounds), while only eight years back less than 40,000 bales were produced. This crop is no longer confined to the small islands off the coast of Georgia and the Carolinas, but is grown on the mainland over a constantly widening area, though from seed annually secured from the islands. The estimates of the share of last year's crop required for bicycle tires range from 7 to 10 per cent. The highest estimate would give 3,600,000 pounds of sea island cotton used for tires, at a cost to the spinners, supposing the price to be 18 cents, of $648,000. The fabric manufacturers are unable to calculate from their sales the number of tires made, since the quantity of material required by different styles of tires varies. But they are among the most optimistic prophets in regard to this year's production of bicycles that the writer has met.—India Rubber World.

PYROCHROMY, OR THE DECORATION OF WOOD, IVORY, LEATHER, ETC., BY FIRE.

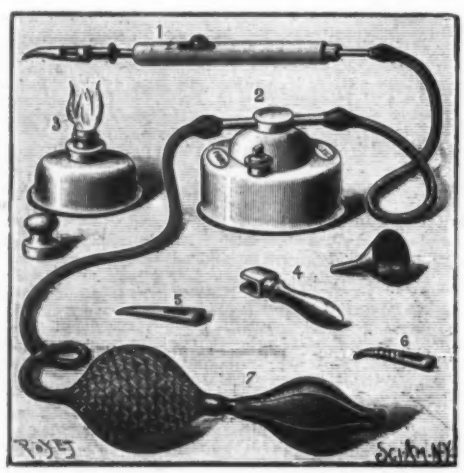
PYROCHROMY is a process essentially French, of recent creation. Fire has been used from remote times for the decoration of wood and leather. The Arabs have always excelled in this art, the implements used being metal rods heated in a brazier or lamp. We need not dwell upon the attempts made to utilize the galvano-cautery for this purpose. This method of decoration has become really practical only since the invention of the Paquelin thermo-cautery. It may be said that this invention has given rise to two new arts—drawing by fire and direct engraving upon glass; but, as wonderful as the instrument is, it has certain defects. By reason of its high temperature it can only be used offhand; and, further, as delicate as may be one's touch, the surfaces with which it is put in contact became carbonized. The manipulation of it is a delicate operation, and then again the lines that it forms become altered and effaced in the long run under the action of air alone.

Commandant Blain, who was one of the first to use the thermo-cautery in decorative art in an original manner, was also the first to perceive its drawbacks and to point them out to the inventor. Such is the origin of the "pyrochrome" (Figs. 1 and 2), which consists of a platinum tube, 2 centimeters in length and 2 millimeters in diameter, fixed to a brass tube and the whole sliding into a handle like that of the pocket knife of our ancestors. The platinum is capped with a sheath of ordinary metal (say German silver), closed or opened at its extremity and of varied form (Fig. 2, No. 1). The instrument is connected with a carbureter containing a liquid hydro carbon inclosed in a porous body. The carbureter is provided with a rubber bulb.

The sheaths are called crayons or stump pencils. Their arrangement has been well studied by Commandant Blain. The apparatus is used as follows: The alcohol lamp, serving to heat the platinum having been lighted, the bulb forces into the carbureter the air that it has drawn from the atmosphere. From the carbureter, the gaseous mixture flows to the extremity of the pyrochrome, where it burns without a flame.

The artist modifies at will the degree of heat of the crayon point, and that of the burned gases issuing from the latter, according to the manner in which he manipulates the push button. In this way he succeeds in producing the gamut of yellows, grays and dark bisters.

Drawing by means of the thermo-cautery has been called pyrography or pyrogravure in foreign countries. The effects obtained with the new instrument are called pyrochromy by Messrs. Paquelin and Blain. The pyrochrome gives lines, shades and soft tints, in coloring them with the entire gamut of yellows, grays and dark bisters. In order to pass from one tone to another, it suffices to push the button in one direction or the other, that is to say, to shove the platinum into the sheath or withdraw it more or less.—La Nature.



THE PAQUELIN & BLAIN PYROCHROME.

FIG. 1.—Box containing the apparatus. FIG. 2.—Details of the apparatus. No. 1, crayon or pencil; No. 2, carbureter; No. 3, alcohol lamp; Nos. 4, 5 and 6, details of the minor parts; No. 7, rubber bulbs.

THE SAND BLAST APPARATUS FOR CLEANING CASTINGS.*

THE invention of the sand blast process by general B. C. Tilghman, of Philadelphia, Pa., in the year 1870, marked the introduction of an entirely new process into the arts. In the twenty-five years that have elapsed since that time the process has been in constant use for an increasing number of purposes, and seems to be a process which is destined to retain a permanent place of its own in manufacturing operations.

The method, stated shortly, consists of projecting a stream of sand, or other abrasive powder, usually dry, but sometimes mixed with water, with more or less force and velocity to strike and pulverize the surfaces of glass, stone, metal and other materials upon which it is directed.

It has been frequently pointed out that in this invention Mr. Tilghman has really borrowed or adopted from Nature herself, inasmuch as he has intensified and put to use a natural force, of which the effects are always apparent under favoring conditions; that is to say, wherever we find large deposits of loose sand exposed to prevalent winds, by which the sand is caught up and blown against any hard substance, such, for example, as the glass in a window, which soon becomes depolished and obscured by the contact of the sand or stone, the surface of which, with time, is sensibly roughened and sometimes scored in a manner quite distinct from ordinary weathering.

The abrasives used in the process include ordinary inland siliceous sand, sharp builders' sand, powdered glass, emery from fine to coarse, chilled iron sand and steel shot; and the stream of the powders is forcibly projected through variously formed nozzles by means of steam, by currents induced by exhaust air, by blasts of air, and latterly and more conveniently by compressed air. Sand from its plenteousness and general suitability is mostly employed. The white beach sand of New Jersey is probably as good as can be found any where for general purposes.

The action of the sand blast is not cutting, not grinding, not abrading in any of the usual meanings of these terms. It is a true pulverization by the successive impact of the grains of flying sand. The sand acts much in the same manner, but on an infinitely reduced scale, as artillery projectiles in breaching a masonry wall, each independently of all the rest. In this action it differs from anything that has preceded it and it still stands alone. It is this difference between its action and all other processes that has caused the general misunderstanding about it above referred to. As all know, the process consists simply in driving a stream of rapidly moving sand against the object to be operated upon. How the sand is given velocity or how the work is presented to the blast are matters of indifference when examining the theory of the process. As the total action of the blast is but the summation of the action of the individual grains, the action of the individual grain is to be considered. If the single grain of the flying sand has no effect when it strikes the work, then no other grains will have any, and the sand blast will be without effect, no matter how long continued. If, however, the single grain of sand has any effect upon the object struck, then the blast will wear it away often at an extraordinary speed, as the number of grains propelled against it is very large, often as many as 5,000,000 per minute.

Grains of sand have numerous angles, and the action of these grains, as also that of the other abrasives mentioned, upon the surfaces of glass, stone or metal, is due to the circumstance that every individual grain in the infinite number in the incessant stream, urged violently forward, has all its energy instantly arrested, transferred and concentrated upon its point of impact, where it produces a minute pit or depression; and, as every grain in the shower acts alike, the abrasion resulting from the whole is perfectly uniform in depth and texture or roughness. The single question, therefore, to be considered is, does the stress at the point of impact between the grain or flying sand and the object struck rise high enough to overcome the strength of the latter?

Three factors determine this: 1. The energy in the flying grain; this belongs entirely to the strength of the blast; 2. The area upon which this energy is expended; this belongs principally to the object struck, although the shape and size of the sand of the blast have some effect upon it; and 3, the strength of the object struck, which, of course, belongs entirely to it. Now, the energy contained in a single flying grain of sand is very small, even when traveling at a very considerable velocity, but it is the exceedingly small area upon which this is expended that makes any cutting by it possible. As an illustration of the above points, take, for instance, the case of a sand blast using sand of an average of 1-50 inch in diameter and propelled by steam of 50 pounds to the square inch, cutting granite. Such a blast, under these circumstances, will cut granite rapidly. Why? Determining the above factors, first, such sand grains will weigh on an average about 0·005 grain and will be moving at the point of impact with the stone about 400 feet per second, and will, therefore, contain about 0·00176 foot pound energy. Now, this is certainly a very small amount, but next, take the area upon which it is expended.

The area of first impact can only be estimated from the following considerations: If a piece of smooth, hard substance is scratched with the edge of crystal, as, for instance, in ruling diffraction gratings and that class of work, lines are readily ruled at the rate of 12,000 to the inch, and when examined under the micoscrope, the lines are seen to be narrow in comparison to the space separating them, being themselves probably not more than 50-1000 inch broad, and it is upon a rectangle of the length of side equal to the breadth of one of these lines that the first impact occurs. This is 0·000,000,000,4 square inch. And the above determined 0·00176 foot pound of energy distributed upon this area is at the rate of 440,000 foot pounds per square inch. Now, the strongest granite can only stand a quiet crushing strain of some 1,300 tons per square foot, or at the rate of some 16,600 pounds to the square inch. The contest between the stress developed at the point of impact or the resistance of the object struck is in this case decided overwhelmingly in favor of the stress developed. The result is that the granite under the point of the first impact is crushed and crumbled to dust, letting the grain of sand progress until in its advance it has expended its energy and increased the area of contact until the pressure there falls below the crushing strength of the granite, and then the action of that grain is over and it rebounds from the stone. The striking edge or point of the grain of sand is also crushed and contributes to increasing the area of contact between it and the granite. The effect of the above sand blast when striking a piece of wrought iron in place of the granite will be that the iron instead of being pulverized like the granite is only indented. The result is that no metal is removed, but a small indentation produced. Other grains striking in the immediate vicinity of this indentation simply shove the metal back into it again and obliterate the effect of the first grain. Thus no effect is produced, but the surface is simply roughened by the indentations of the sand grains. This is the normal effect of the blast upon all metals. If they are exposed for a long time to the action of the sand, as in a sand blast machine, metals wear away, because the surface metal is exhausted by the constant bending so

* A paper read by Mr. Fred. C. Brooksbank at the Foundryman's Association on March 4.—From the Iron Age.

that it at last breaks. If the blast is directed upon a piece of soft rubber, the same action as in the case of the metal takes place, but in this case the elasticity of the rubber is such as to enable it to resume its original shape after the force of the impact has been expended in deforming it, and there is no residual effect whatever upon the rubber, the grain of sand rebounding with almost its original velocity. These three actions and the combinations of them explain all the different effects of the sand blast, in cutting and refusing to cut various substances.

In surface obscuring or ornamenting, such as in glass work, for which the sand blast has been more used than for all other purposes combined, the problem is entirely different. The effect wanted is to break the continuity of the surface struck, and this once obtained any further force in the blow of the sand is wasted, and an exceedingly great number of light blows is what is desired. Therefore, a very fine sand is used and a large quantity thrown in proportion to the propelling jet, which gives a moderate velocity. So important is this adaptation of the size of sand to the work that if two exactly similar machines are taken, one using fine and the other coarse sand, and both using the same pressure of either air or steam to drive the sand and the same size jet, the machine using fine sand will obscure three times the work that the machine using coarse sand will do. But in cutting or perforating glass or stone the machine using coarse sand will do three times the work of the machine using fine sand. In one case the blows are too few to break up much surface and in the other case they are too light to do much cutting. Thus, by use of sand unsuited to the work, the efficiency of a good machine can be reduced over 60 per cent.

The earliest forms of apparatus perfected was the high pressure steam jet described in the patent of 1870. In this form of apparatus a small jet of high pressure steam of an annular shape escapes into a larger tube and draws along with it a current of air through a central tube, which is surrounded by the annular steam jet. This inspirated current of air carries with it a large portion of sand and becomes mixed with the escaping steam and is thrown directly against the work at a high velocity. The nozzle tube is made of hard white iron and so constructed as to be cheaply and easily replaceable. This form of jet for hard, heavy cutting is as efficient in output of work in proportion to power used as anything that has been constructed since. Its other disadvantages, however, have caused it to be abandoned in favor of other devices of more modern construction. Among these were chiefly the wetting of the sand each time it was used; clogging of the sand feed pipe if this drying was perfectly done; enveloping the work in a cloud of steam, so that the progress of the work could not be followed by the operator; cracking glass articles by the sudden and unequal application of heat to them, and rusting all articles of iron or steel, subsequent to the cleaning by wetting them with hot water from the condensed steam. The use of compressed air avoids all these disadvantageous qualities. In spite of all these disadvantages, however, this system was used for a long time to a considerable extent in the stone trade, among other things doing the marking of over 100,000 tombstones in the national cemeteries, cutting down the whole face of the stone and leaving the inscription in raised letters about one-quarter inch high.

For cleaning metals, however, these disadvantages have totally prevented the use of the steam jet. Compressed air was tried in the same form of jet. Although it did good work it did not succeed practically or commercially on account of the great expense of providing a sufficient supply of compressed air at the pressures required. The small amount of work that a jet of compressed air used in one of these old induction feed steam jets would do was remarkable, and most discouraging in comparison with what a jet of steam would do under the same pressure. The whole class of induction feed jets would not work reliably at the lower and more economical air pressures. They, however, would work well, cost not considered, and completely obviated the faults just referred to of the steam jet.

In a recently designed machine these points have been retained and there has been secured also the full efficiency of the blast, due to the pressure at which it is used, unreduced by the admixture of any dead air carrying the sand with it, at just the place where the maximum velocity is desired. This machine uses air at all pressures, but those about 10 pounds to the square inch are found to be the most satisfactory. By immersing the whole sand supply in an atmosphere of air at the above pressure, contained in a tight reservoir, the advantages of a purely gravity feed are obtained, uncomplicated by any questions of difference of pressure inside of the jet tubes and without. Then, by the use of a flexible tube of considerable diameter, the sand and air, in a mixed current, are carried to a point where they are to be used. Here the flexible tube is terminated by a hard chilled iron cone, terminating in a tube of small diameter. In traversing this latter portion of its course the mixed current of sand and air increases its velocity inversely as the square of the diameter of the tube, and is finally discharged from the end of the blast nozzle at the full velocity due to the pressure behind it. An air lock arrangement for transferring new supplies of sand into the sand reservoir, while still under pressure, and valves for operating and graduating the air and sand supply, with a suitable compressor for furnishing the supply of compressed air, complete the arrangement. This machine is comparatively new in this country, but has been used to a considerable extent in England and the Continent for cleaning off scale from sheet metal and castings and forgings. The machines are built in different sizes, and, of course, their output of work depends strictly upon the amount of compressed air that they use per minute. A machine using 60 cubic feet of air per minute requires 3 indicated horse power to run the compressor, which furnishes this amount of air compressed to a pressure of 10 pounds to the square inch.

At this volume and pressure the work accomplished on ordinary rolled steel plates is 1 square foot of scale removed per minute. Iron plate usually has thicker scale and requires slightly longer time. Forgings and castings differ so much in the nature of their scale, both from kind and heat of iron, kind of moulding sand and several other particulars, that it is impossible to give any general rate which will be sure to suit more than the individual case which is considered. Trial is the only safe criterion.

USES OF THE SAND BLAST.

The recent improvements and inventions of Mr. Mathewson, manager of the Tilghman Sand Blast Company, Sheffield, England, have given a new impetus to the use of sand blast for a great variety of purposes. In metal it is used for the removal of the hard scale, so destructive to cutting tools, from castings and forgings. Among the applications are the removal of the scale from sheet iron and steel prior to enameling, galvanizing, nickeling, tinning, etc., the cleaning of tubes and brazed joints, largely used in bicycle work, sharpening the teeth of files, for granulating or frosting electroplate, gilding metal, gold and silversmiths' work and jewelry, the reduction to clean metal surfaces of larger works, ranging from steel forgings of safes to armour plates, on stone, slate and granite, for incised carving and inscriptions in intaglio or relief, for cleaning off the grime from stone, granite and brick buildings, and in contrast to this last, for the most delicate drawing for lithography.

Among other purposes it is employed for removing fur and deposits in tubes and tanks, for cleaning off accumulations of paint and dirt within iron ships, for roughening the surfaces of metal rollers, for decorating coat and other buttons, for granulating glass to give it a key for ornamental painting by hand, for piercing the apertures in glass ventilators, for marking cakes of glue and cement, for marking pottery and in the manufacture of ornamental tiles, for smooth facing bricks to receive white glass or enamel, for refacing grindstones, emery and corundum wheels, for granulating celluloid films for photography, and on wood to bring out the grain in relief, and latterly, for blocks for printing.

Another recent improvement in connection with the use of sand blast is the application of it in connection with tumbling barrels. These barrels run very slowly (two or three revolutions per minute), consequently there is little risk of breaking fragile castings, neither are the edges of them worn off and destroyed, as in the case of ordinary rattling at high speed. The castings are not cleaned by tumbling, but by sand blast inserted at one or both ends of the barrel. The usual time consumed in cleaning a charge of this barrel is from 20 to 30 minutes. The latest design of this machine is arranged at an elevation directly over the sand blast apparatus, which has two flexible tubes and nozzles. These are inserted into each end of the barrel, which is inclosed and provided with an exhaust fan to carry off the dust. The barrel is perforated with small holes, through which the sand falls through a hopper and directly back into the sand blast apparatus, thus making it almost entirely automatic.

CLEANING IRON WORK BEFORE PAINTING.

There is another application of the sand blast which is just beginning to attract the attention that it deserves. This is in the preparation of metal work of all kinds for painting as a protection against corrosion of all kinds, principally, of course, in protecting iron work against the weather. For this purpose the one necessary condition is to get a close contact between the metallic iron and the oil of the paint. If this is secured the paint will last and stick on in a manner entirely unknown in the present ordinary commercial painting of iron structures. If this absolute contact of paint and metal is not secured and the thinnest coat of oxide, either rust or scale, intervenes, the painting is in a great measure useless. The paint not reaching the iron cannot stick to it; it can only stick to the coat of oxide which it can reach, and as a result when the coat of oxide loses its hold on the iron and drops the paint comes with it.

The difference between what can and should be done in the way of protection of iron by paint and what usually is done is shown in the case of ship plates, when, as is sometimes found, the numbers and marks painted on the plates in the rolling mill when the sheets are perfectly clean, just from the rolls, are found of the full original thickness of the plates, while the rest, painted in the ordinary way, is so much corroded as to render it necessary to replace the plate. This degree of protection is what should always be obtained and which can best be obtained if iron is thoroughly cleaned by sand blast immediately before it is painted. And we will venture to predict that it will not be a long time before the specifications of structural iron work to be protected by paint will usually call for a thorough sand blast cleaning immediately before painting.

Another use for which we predict a large demand for sand blast work is in boiler making. At present the sheets covered with oxide are placed together and riveted up. The blows of the riveting thoroughly pulverize the scale on the plates where they lap on each rivet, leaving a thin layer of powdered scale between the plates, through the interstices of which steam and water under pressure will find their way. To prevent this the excessive calking now used is necessary. If the sheets were clean metal to metal, without foreign substances between them at the joint, much of the present calking would be unnecessary. This would leave the full strength of the rivets and plates to withstand the internal pressure instead of having a large portion of their strength taken up in withstanding the initial strains produced by calking.

The ordinary method of attempting to produce a clean metallic surface on castings, forgings, etc., for these and other purposes is by pickling. This process, apart from its numerous well-known disadvantages, which make all who have anything to do with it wish to replace it with some other process, has a serious effect upon the internal structure of the iron, as the following reports of experimental results will show:

THE EFFECT OF PICKLING IRON AND STEEL.

The effect of pickling and rusting on the strength of iron and steel has been shown by A. Ledebur, of Berlin. Rails, joists and bars were subjected to various conditions: 1. In the condition as delivered. 2. After exposure for purpose of rusting. 3. Galvanized and tested at once. 4. Galvanized and exposed for a time. 5. Pickled in acid and immediately tested. 6. Pickled and kept for a time in a dry place. The pickling was done with sulphuric acid diluted with water in the proportion of 1-100. The samples were tested for transverse, tensile and compressive strains and under a falling weight, these experiments being made on the same sample for each of the six conditions. The bending tests with wrought iron joists showed substantially the same for all the conditions; the maximum loads carried showed differences, being highest in the natural condition and lowest when freshly pickled. Rusting also produces a diminution of strength more apparent in the galvanized specimens than in those not galvanized. In the instances where the specimens were broken the diminution in strength is said to be very decided in the pickled and perceptible in the rusted specimens. The figures are: Breaking strain under condition 1, 35 tons; under condition 2, 33·9 tons; under condition 4, 32·7 tons; under condition 5, 29·6 tons, and under condition 6, 30 tons. The steel specimens showed results which follow the same law.

When iron is placed in acid some of it is dissolved and hydrogen liberated. This gas is supposed to be of the nature of metal, and as such it combines with and forms an alloy with the iron, which becomes quite brittle till the iron is heated and the hydrogen is liberated, when it regains its tenacity. If a piece of wire be broken when it has thus become alloyed with hydrogen, and the end wetted, the bubbles of gas may be seen rapidly passing through the water. This condition of things was observed and investigated by W. Johnson, of Manchester, and afterward by Prof. Osborne Reynolds. The latter showed that if an iron tube be closed at one end and filled with oil and placed in an acid solution, hydrogen is liberated from the outside, which passes through the wall of the tube, displacing the oil, so that the gas may thus be easily collected from the inside of the tube. There is a possibility, therefore, that when iron is rusting the hydrogen liberated may similarly combine with the iron and render it brittle or reduce its strength, and this is a question of much importance to engineers.

PICKLING HAS DISADVANTAGES.

Some interesting experiments in regard to the decrease in the strength of iron after being pickled and galvanized were recently reported in Tin and Terne. A dozen eye bolts, all precisely alike so far as could be perceived by external inspection, were carefully selected. Six of these eye bolts were laid to one side and the others sent away to be galvanized. A testing machine was not at hand, but six bolts were connected together, one being connected to each of the ungalvanized ones. Then they were placed between two pieces of iron and the nuts screwed up until the eye bolts broke. Invariably it was found that the galvanized eye bolts were the ones to break; not in one instance did the ungalvanized ones give way. Boat builders also state that galvanized iron is "rotten." They say that when great strength is required, select the iron and have the fittings forged by a good smith, but do not have them galvanized. Galvanized iron is frequently used in places where little strength is required, but where rust would be objectionable. For this purpose galvanized iron leaves nothing to be desired, but where the full strength of the material is desired and rust stains are objectionable, the object may be obtained by cleaning them with the sand blast process and afterward coating them by the cold galvanizing process, both of which methods are becoming well known and largely used for the above purposes.

The foregoing may be of more or less interest to you, but I take it that what more nearly concerns you, and which you may ask: "Does sand blast pay for foundry use?" I say yes. But as I said before, it is difficult to approximate on general work. I am safe in saying, however, that on ordinary iron, steel, brass and bronze castings, one man operating a sand blast apparatus consuming 120 cubic feet of air per minute will clean more surface and remove more cores in a given time than is possible for from six to ten men to do with hammers, chisels and brushes. And the finished work left by the sand blast is infinitely better than what can possibly be done by hand laborers. I have proved this repeatedly. I have never yet seen the burnt sand or scale that sand blast would not remove, and remove rapidly. Not only is it a great saving in time and labor in the actual cost of castings, but a further saving is made in castings to be machined. The removal of the oxide in itself is a great saving on tools, and in many cases the tools can be run at an increased speed. This particularly applies to milling cutters.

Difficult and intricate cores are readily removed and have greatly astonished some of our well-known engineers. One peculiar thing in cleaning steel castings in which large quantities of wire nails are used is the cores. When subjected to the sand blast the sand is eaten away first and subsequently the nails will fall to the ground, sand blasted, perfectly clean and in condition to be used over again. I could give you many instances that have come under my notice of the quick removal of cores, and will mention one that was accomplished in five minutes. This was considered to be a job of from three to four hours for one man with hammer and chisel. Quite a number of people who have adopted the sand blast recently and who previously used facings have discontinued the use of such, and have assured me that the sand blast has enabled them to reduce the cost of their product. In conclusion, I would say that the only objection to sand blast that can be found to its use in foundries is that it has an unpleasant trick of showing up defects and making them plainly discernible.

Mr. Brooksbank exhibited several specimens showing the cleaning power of the apparatus.

SOLID SOLUTIONS.

By JAMES WALKER, in Science Progress.

IF we define solutions as homogeneous mixtures of substances in variable proportions, we are at once obliged to admit the existence of solid solutions, for there are many mixed solids which fulfill the requirements of this definition. Common potash alum, for example, can crystallize together with ammonia alum, and form mixed crystals which are perfectly homogeneous and of the same composition throughout, although the proportions of the two constituents may be varied at will by proper selection of the aqueous solution from which the crystals separate.

We are inclined, however, to look in solutions for something more than mere homogeneity and uniformity of composition, and perhaps one of the most obvious characters of a liquid solution is this, that should it at first be of different composition in different parts of its mass, there is always present the tendency of the dissolved body to attain a uniform distribution throughout the solvent. The process of equalization of the

composition, or diffusion, occurs in all solutions which are more concentrated in one part than in another, the dissolved substance moving from the place of greater to the place of less concentration. Diffusion in solution goes forward very slowly if the liquid is protected from mechanical disturbance and sudden change of temperature, months being requisite for the attainment of uniform concentration if a comparatively short column of pure solvent is placed above a denser layer of strong solution contained in the bottom of a cylinder. If diffusion takes place in solids, we might expect it to proceed even more slowly.

A class of substances which form in some sort a connecting link between liquids and solids, and are specially suited to the study of diffusion phenomena, is to be found in jellies. Graham, to whom we owe our first exact knowledge of diffusion in liquids, prepared a stiff jelly containing common salt in solution in one part, and compared the rate at which the salt diffused in it with the rate at which salt diffused in pure water. He found that the diffusion in the jelly took place almost, if not quite, as fast as in water itself. The composition of the jelly was 2 per cent. gelose and 98 per cent. water, so that, as far as actual substance was concerned, the salt had to meet practically the resistance of water alone in both cases, and the experiment showed that the mere change in apparent condition of the whole mass had little or no influence on the rate of diffusion. Subsequent experiments have served to confirm Graham's results.

When we pass to solids proper, we find that instances are not wanting of what is apparently diffusion within them. Van't Hoff in his fundamental paper on solid solutions gives numerous examples. In the preparation of steel by the cementation process bars of wrought iron are packed in charcoal and subjected to a red heat for several days. The charcoal gradually penetrates the iron and converts it into steel. It matters little for our purpose what the particular form is that the carbon assumes during its passage through the iron—in some fashion or other it reaches the center of the dense bar. The distribution of the carbon, too, if the operation is interrupted before uniformity has been attained, is precisely what would be expected if the phenomenon were one of real diffusion; and the influence of time is the same in both processes. Not only has carbon been observed to pass through iron, but it has even been proved to travel slowly through porcelain, when porcelain crucibles have been heated in a bed of graphite.

When a metal such as copper is deposited galvanically on another metal, it penetrates beyond the surface of the latter into its substance, and zinc objects which have been lightly coppered are, even when protected by a coating of varnish, occasionally observed to become white again owing to the gradual mixing of the two metals near the surface.

Professor Spring, of Liége, who has devoted special attention to the chemical behavior of solids under high pressure, has supplied some interesting instances of phenomena which can only be explained by the assumption of solid solutions. When equivalent proportions of barium sulphate and sodium carbonate are finely powdered, intimately mixed, and subjected to a very high pressure, a double decomposition takes place with formation of barium carbonate and sodium sulphate. The decomposition, however, is not complete, only 20 per cent. of the original substances being transformed. If, on the other hand, we start with a mixture of barium carbonate and sodium sulphate and compress it, we find that the reverse transformation now occurs, barium sulphate and sodium carbonate being formed, and that to the extent of 80 per cent. of the original substances present. Here we are evidently dealing with a state of equilibrium between the four substances above mentioned, which can only exist together permanently under pressure in certain definite proportions. If these proportions are departed from, the system so transforms itself that the requisite state for equilibrium is attained. Now this of itself points to the substances existing here in a state analogous to that of bodies in liquid solution, for we know that in general definite proportions are necessary in solutions for stable equilibrium to exist. In the case of solids the general rule is that when they are in equiiibrium under given conditions in one proportion, they are in equilibrium under the same conditions, in every other proportion. The behavior, then, of these solids under pressure is analogous to the behavior of substances in solution, and different from the ordinary behavior of solids. The continuance of the pressure is not essential to the establishment of such a definite solid equilibrium, for Spring has shown that by relieving the pressure after 73 per cent. of a system of barium carbonate and sodium sulphate had been transformed, the process continued, though less rapidly, and after a week had reached the proportion of 80 per cent. necessary for equilibrium. Here diffusion must have played a part, for no matter how finely divided the reacting substances originally were, their surface of contact (where alone the mutual decomposition could take place if there were no diffusion) must have been comparatively small.

It is well known that some metals have the property of allowing certain gases to pass through them under favorable conditions, the most thoroughly investigated instance of this kind being the permeability of the metal palladium to gaseous hydrogen at moderately high temperatures. At about 300° C. hydrogen can pass quite freely through a palladium septum, and it is difficult to conceive the nature of this phenomenon without admitting the existence of diffusion in the solid. Whether the hydrogen is dissolved in the palladium or forms a compound with it, as has been asserted, is of little consequence, for in the latter case the compound superficially produced must have possessed the power to penetrate the remaining metal, or to allow of the passage of hydrogen through itself.

Connected with the process of diffusion in solution we have the phenomena of the conduction of electricity in solutions or electrolysis. Here the electric current is carried by material particles, and the resistance that these experience in their passage through the solution is of the same nature as the resistance offered to diffusion. Helmholtz in his Faraday lecture drew attention to the fact that glass behaves as an electrolyte toward an electric current, i. e., that the current in passing through the glass is associated with two currents of particles moving in opposite directions. The particles traveling toward the negative pole of the battery have since been proved to move faster than those moving toward the positive pole. Lehmann also has shown that when two silver electrodes are immersed in fused iodide of silver, which is afterward allowed to solidify, and a current of electricity is passed through the solid iodide, one of the electrodes increases in weight at the expense of the other, and that the phenomenon can be reversed by reversing the current.

These examples will suffice to indicate that we are not without data to establish an analogy between the behavior of certain solids and the behavior of ordinary liquid solutions. Since the appearance of Van't Hoff's original paper on the subject a considerable number of researches have been published more or less directly bearing on the question, but the results achieved have on the whole been small, owing chiefly to the experimental difficulties encountered.

An important application of the idea of solid solutions was made by Van't Hoff in explaining the abnormalities that are sometimes met with in the determination of molecular weights by the lowering of the freezing point in solutions. It had been proved theoretically that the freezing point of a given solvent should be depressed to a certain value (calculable from the freezing point and the latent heat of fusion of the solvent) when the solution was of normal concentration, i. e., contained one gram-molecule of dissolved substance per liter. The nature of the dissolved substance should be without influence on this value. Now, while it was ascertained experimentally that this theoretical relation was in the vast majority of cases accurately fulfilled, yet there remained certain combinations of dissolved substance and solvent which gave values of the depression constant altogether at variance with the calculated value. Thus, metacresol dissolved in phenol gave a depression of 48 instead of 74, and thiophene dissolved in benzene a depression of 34 instead of 53. Van't Hoff's explanation of these and similar abnormally low values of the depression was that the freezing point observed was not in the strict sense the freezing point which had been assumed in the theoretical reasoning. The true freezing point of a solution is the temperature at which the liquid is in equilibrium with the solid solvent. The freezing point of an aqueous salt solution, for example, is the temperature at which it can exist in contact with pure ice without the ice melting or without fresh ice being deposited from the solution. Now in the exceptional cases above alluded to it is known that the solid and the solvent have a tendency to crystallize together, i. e., to form mixed crystals, so that the substance that separates out is not the pure solvent but rather a solid solution. The temperature at which such a solid solution would be in equilibrium with the liquid solution might not by any means be the freezing point of the solution as above defined. The apparent observed freezing point of the solution, therefore, would not in general coincide with the calculated depression, and Van't Hoff from theoretical considerations showed how the divergence could be estimated from a knowledge of the composition of the solid which actually separated out from the solution on cooling.

That the abnormal values for the points of solidification depend on the separation of the dissolved substance along with the solvent has now been experimentally verified in a considerable number of cases. Heycock and Neville found that for the case of solutions of antimony in molten tin, the freezing point of the tin was raised instead of lowered by the presence of the second metal. Kuster has shown that this and similar instances are susceptible of a very simple explanation. The two metals separate out together in very nearly the same proportion as that in which they remain behind in the liquid, so that the solution solidifies as a whole. In such circumstances the point of solidification of the liquid can be calculated by the simple mixing formula. If the melting point of each pure substance is multiplied by the proportion in which it exists in the mixture, the sum of the two numbers thus obtained will give the point of solidification of the solution. As antimony melts 200 degrees higher than tin, the admixture of the former in however small proportion will, since the mixture freezes as a whole, raise the point of solidification instead of lowering it, as would be the case if pure solid tin separated from the liquid on cooling.

Not only do solutions exhibit a lower freezing point than that of the pure solvent, but they also exhibit a lower vapor tension. The pressure of aqueous vapor over salts containing water of crystallization may in many cases be measured with accuracy, and there it is found that the isomorphous admixture of another salt lowers the vapor pressure of water which is in equilibrium with the solid. Thus the vapor tension of a mixed crystal of ordinary alum with iron alum is less than the vapor tension of either of its components. In this respect then the mixed crystal behaves as a solid solution. Again, the solubility of a substance is diminished when it itself acts as a solvent for another substance insoluble in the original solvent. Of the three liquids, ether, water and benzene, ether and water are partially miscible, benzene and water are immiscible, and ether and benzene miscible in all proportions. Suppose we take water as the original solvent—then on shaking it up with ether we find that the latter dissolves to a certain definite extent in it, i. e., possesses a certain solubility in water. If now we previously dissolve benzene in the ether which we shake up with the water, we find that the water will now take up less ether than before. The solubility of ether in water is thus diminished when benzene is dissolved in it, and this behavior is characteristic of all such combinations of substances.

A case of this kind where two solids play the part of the ether and benzene in the previous instance has been thoroughly studied by F. W. Kuster. The solid hydrocarbon naphthalene is, like the hydrocarbon benzene, insoluble in water; β-naphthol, on the other hand, is, like ether, sufficiently soluble in water to permit of accurate estimation. But naphthalene and β-naphthol can crystallize together in any proportion so as to form a complete series of isomorphous mixtures, the melting points of which vary according to the rule given above for mixtures of antimony and tin. A comparison of the amount of β-naphthol dissolved by a given quantity of water from such mixtures led to somewhat unexpected results. Instead of the addition of a small quantity of naphthalene to β-naphtnol lowering the solubility of the latter in water, it was found that mixtures containing as much as 30 per cent. of naphthalene had precisely the same solubility as β-naphthol itself. As more naphthalene was added the solubility increased slightly, afterward to diminish continuously to zero as the mixture was made to contain more and more naphthalene. The explanation of this behavior suggested by Kuster is that naphthalene and β-naphthol are capable of forming a chemical compound consisting of one molecule of each substance, this compound being decomposable by water, an assumption by no means improbable, as many similar cases have been observed. If we allow further that the solubility of the compound is greater than the solubility of β-naphthol, the results are satisfactorily accounted for. The diminution of solubility when much naphthalene is present is the normal depression of the solubility of the compound by the addition of excess of naphthalene. The solubility greater than that of pure naphthol is the solubility of the compound naphtholnaphthalene. The constant solubility (equal to that of β-naphthol) observed when there is little naphthalene in the mixture is the solubility of β-naphthol, for the naphthalene in the mixture is in the form of the compound naphtholnaphthalene, which is decomposed at the surface by water into naphthalene and β-naphthol, which exists now alongside of each other and not in the intimate union of a crystalline isomorphous mixture.

In connection with the results of these experiments Kuster is inclined to make a distinction between crystalline isomorphous mixtures and solid solutions proper, because in the former there is practically no diffusion owing to what may be termed the rigidity of the crystalline structure. He admits, however, that no absolutely sharp line can be drawn, as there are various intermediate degrees in which diffusion may take place. A reference to the examples of diffusion in solids previously cited in this paper will show that they all occur in amorphous bodies without any regular structure.

A point of considerable interest in the theory of solid solutions is that it affords us the possibility of determining molecular weights of the dissolved substances, and since in isomorphous mixtures we usually attribute similarity of molecular structure to the two components, we can also in this case form an estimate of the molecular weight of the solid solvent. From his experiments on the amount of β-naphthol dissolved by water from mixtures of that substance with naphthalene, Kuster was able to calculate with a high degree of probability the molecular weight of each of these substances in the solid state. In the first place he found that with mixtures containing excess of naphthalene the ratio of the square root of the concentration of β-naphthol in the solid mixture to the concentration in the aqueous solution saturated by that mixture was very nearly constant, varying but little with the actual composition of the mixtures taken. The general theory of solutions asserts that when a substance (here β-naphthol) is divided between two immiscible solvents (here water and naphthalene, or naphtholnaphthalene), it will be distributed in a constant ratio between the two solvents, no matter what amount of it be taken, provided only the molecular weight of the substance is the same in both solvents. In the case investigated this does not hold—the ratio of the concentrations in the two solvents is not constant; and the molecular weight of β-naphthol dissolved in water is therefore different from the molecular weight of β-naphthol "dissolved" in naphthalene. The theory further asserts that when, as in the present instance, the concentration in one of the solvents is proportional to the square root of the concentration in the other solvent, the molecule in the second solvent must be twice as great as the molecule in the first. We know that β-naphthol dissolved in water has the normal molecular weight corresponding to the formula $C_{10}H_8O$; in naphthalene solution it has consequently the molecular weight corresponding to the formula $(C_{10}H_8O)_2$.

The theory of solutions likewise enables us to calculate the molecular weight of the naphthalene in the above experiments from the diminution of the solubility of the β-naphthol in water as it dissolves more and more naphthalene. In the case before us the question is slightly complicated by the existence of naphtholnaphthalene molecules, but Kuster was able to arrive at the result that naphthalene must have double the molecular weight in the state of solid solution that it has in the state of vapor viz., $(C_{10}H_8)_2$.

Another well-investigated case of solid solutions is that offered by the absorption of hydrogen by palladium. Troost and Hautefeuille, in order to obtain information as to the state in which the hydrogen existed within the metal, made an extensive series of observations of the pressure of hydrogen in equilibrium with palladium containing different amounts of hydrogen. They found that with compositions of the solid up to one atom of hydrogen to two atoms of palladium, the pressure of hydrogen remained constant at 100° C., after which it increased rapidly as the proportion of hydrogen in the solid increased. The analogy between this case and the case of the solubility of mixtures of β-naphthol and naphthalene in water is at once apparent. In both instances we have constancy of pressure (gas tension) and solubility (solution tension) within a certain range of composition, and then rapid variation with further change of composition. The conclusions arrived at in both instances are also similar. The constant solubility was attributed by Kuster to the formation of a compound naphtholnaphthalene—the constant tension was attributed by Troost and Hautefeuille to the formation of a compound Pd_2H, in which any excess of hydrogen was then absorbed. Quite recently, however, grave doubts have been thrown on the existence of this compound. A very careful repetition and extension of Troost and Hautefeuille's experiments by C. Hoitsema has proved that the constancy of tension observed by these investigators was not absolute but only approximate, and that under slightly varying conditions the apparent constancy disappeared altogether. It would seem, therefore, that no compound of palladium and hydrogen is formed when the gas is absorbed by the solid, the state of the hydrogen being rather one of simple solution in the palladium. A comparison of the concentrations of the hydrogen above the palladium and of the hydrogen in the palladium indicates that at very low pressures the hydrogen in the metal exists as molecules only half as great as those of the gas, i. e., as molecules consisting of only one atom. At higher pressures the concentration of the free gas and that in the palladium stand in a nearly constant ratio, from which it is to be inferred that the molecule of hydrogen in the metal, as well as the molecule of

gaseous hydrogen, is represented by the formula H_2. A problem which has long interested chemists is the determination of the nature of the process involved in dying. Some contended that the process was one of chemical union of the dye with the substance of the fiber, others that it was merely one of mechanical absorption. In 1890, however, O. N. Witt propounded a new theory which, on account of its plausibility, met with a ready acceptance in many quarters.

According to Witt the state of the dyestuff in the fiber is one of solid solution, and many analogies were advanced in support of this assertion. For example, dyed materials show the color, not of the solid dyestuff, but of the dyestuff in solution, when there is a difference of color between the two states. Solid fuchsine is green, its aqueous solutions are red, and so also are materials dyed with it. The dyestuff rhodamine in the solid state exhibits no fluorescence, in solution it does, and silk dyed with rhodamine is fluorescent likewise. The theory of Witt thus appeared very promising as an explanation of the phenomena of dying, but a closer investigation has shown that it cannot be accepted unconditionally, although some modification of it may be found to satisfy the experimental requirements. It has been proved in a considerable number of instances now investigated that the concentrations of the dye in the dye-bath and in the fiber do not stand to each other in a relation of simple proportionality, but the concentration in the bath is roughly proportional to a power (usually 3 to 5) of the concentration in the fiber. Now on the theory of solid solutions this indicates that the molecule of the dye in the water is three to five times as great as the molecule of the dye in the silk; but this cannot be the case, for the molecule of the dyestuff in aqueous solution can be shown by other means to be the simplest possible. The numbers rather indicate analogy to the process known as absorption from solution. Substances like animal charcoal and platinum black have the property of condensing gases in the extensive surface they present. Similarly they can abstract certain substances from solution, as may be seen in the employment of animal charcoal for the decoloration of solutions. The relation between the concentration in the solution and that in the charcoal proves to be of the same kind as is met with in dyeing, so that we are led to suspect a similarity in the nature of the two processes. The so-called "iodide of starch," the blue compound formed when starch and iodine solution are brought into contact, would appear to be a substance of the same nature as a dyed fiber and as charcoal saturated with an acid from solution, for the concentrations of the iodine in the aqueous solution and in the starch obey approximately the same law as in the other instances.

We are therefore forced to conclude that whatever success has attended the application of the theory of solid solutions to other processes, the theory can scarcely without modification be accepted as giving an explanation of the process of dyeing.

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MEASURING EYES FOR GLASSES WITHOUT ASKING QUESTIONS.

By A. JAY CROSS, New York.

THERE are several recognized methods employed by oculists and refracting opticians for measuring eyes, either for the purpose of improving vision, or of relieving what is called "eye strain." The method that is most commonly used consists in placing various lenses, either singly or in combinations, before the eyes of a patient; then by asking questions regarding different sized lines and letters placed twenty or more feet away, endeavor to ascertain the proper measurements. The principal difficulty, however, that is experienced by those who use this method is the inability of patients to answer the questions correctly; especially is this true regarding children and persons of dull perceptions. The aim, therefore, of those who are engaged in this exact and important scientific work has been to find a reliable method whereby accurate measurements can be obtained without quizzing their patients. Skiascopy, as it is termed, or a study of the shadow, is a method that is fast becoming popular with the more advanced examiners. It consists in reflecting rays of light from a gas jet, or other luminous source, through the pupil of an eye on to the retina, then by refracting the return rays, as they pass through a small aperture in the center of the reflecting mirror, determine thereby the correcting lens required. The principle involved is a simple one. It is well known that a perfect eye will focus parallel rays of light exactly on its retina without calling into service its adjusting apparatus; therefore, it follows that rays of light returning from the retina of such an eye will leave it parallel also. (See P, Fig. 1.) And by following a single ray it can be traced to a corresponding position on the retina of an observer. (See O, Fig. 2.) Hence, any movement on the part of the eye, O, will be followed by a similar movement at the apparent source of the ray in eye, P, and if the observer causes the reflected light to move from side to side before the patient's eye, the shadow or spot will move in the same direction. This law holds good in far-sighted as well as in perfect eyes, for in the former, where accommodation is relaxed, the rays of light emerge divergent. In near-sighted eyes, however, the reverse obtains, and rays of light emerge convergent. If, therefore, a single ray be followed from the near-sighted eye, P, in Fig. 3, to the perfect eye, O, in Fig. 4, it will be seen to reverse its image at the far point of the near sighted eye, and arrive at the retina of the observer's eye in an inverted position. Hence, any movement of eye, O, will be followed by an opposite movement at the apparent source of the light ray in eye, P, and if the observer's eye be moved from side to side, the shadow will move in the opposite direction. It is the movement of this shadow with, or against, the movement of the reflected light that must be considered. And it will be noted that all eyes under examination must be either near-sighted at the time of examination, or rendered so by a convex spherical lens whose power is sufficient to bring the patient's visual far point in front of the observer. Fig. 5 illustrates this, as eye, P, is a perfect one, and rays emerge parallel, being made convergent after they leave it.

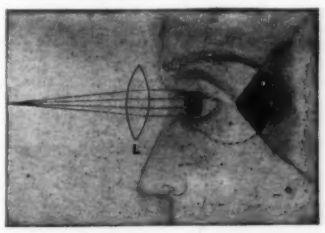
O, FIG. 2.

P, FIG. 1.

This far point in the natural or artificially near-sighted person is called the point of reversal, for if the observer's eye is between this point and the eye of the patient, the shadow will move with the movement of the mirror, but if it is beyond this point, the shadow will move against the movement of the mirror. If lens, L, in Fig. 5, be a convex spherical one, of a given focal power, it will converge the parallel rays as they emerge from eye, P, at a point, its focal length, in front of it, and this would also be the point of reversal for the shadow; but if the point of reversal was found to be further away, then the observer would know that the eye was far-sighted, and if the point of reversal was found to be nearer, then the eye would be near-sighted.

The finding of the various points of reversal for all the meridians of the eye is the data upon which the skilled examiner calculates the formula for proper glasses.

Fig. 6 may give something of an idea as to the appearance of the shadow as it flits across the area of the pupil. Observation as to the brilliancy of the light in the pupil, and the rapidity of movement of the shadow, are also aids in determining the exact measurements.



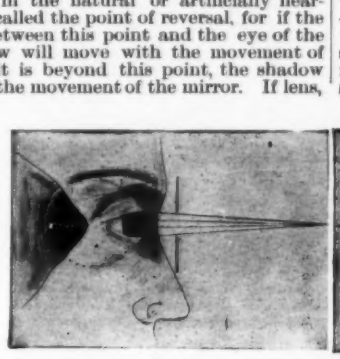
P, FIG. 5.

FIG. 6.

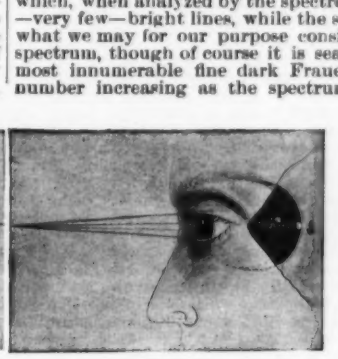
MONOCHROMATIC IMAGES AND PHOTOGRAPHY.

By W. DE W. ABNEY.

A STUDY of a source of light, such as of the sun or a candle flame, is often not devoid of interest, and such study may become of more value when it is conducted by means of the spectroscope. For instance, the composition of a flame may be well examined by throwing on the front of a spectroscope its sharp image of such a size that an entire section of it falls on the slit. Remembering that the spectrum is a succession of images of the slit in the various colors, it can be seen that the slit thus illuminated gives a spectrum of the section of the light passing through it. With a candle flame the luminous portion of the flame will give a continuous spectrum, while the blue part or base of the flame will be shown by a few bright lines in the green, blue, and violet which, when combined, give the color noted by the eye. Or, again, the images of the carbon points of the electric arc light are seen as giving continuous spectra, the negative pole showing much less brightness in the blue than the positive, while between these two spectra is a black gap broken by fine bands of lines lying principally in the blue and violet. These spectra, of course, can be photographed in the ordinary way, and a record kept, but it by no means follows that in the photographic record of the spectrum of one section we get an exact pattern of what would be shown by any other section of this source of light. To turn to another source of light, we may photograph in a photoheliograph an image of the sun, say of four inches diameter, and if the exposure has been properly made we shall have a picture of its surface showing the mottling and the sunspots, but very rarely will there be obtained any trace of the prominences which extend beyond the sun's limb, and which from eclipse observations, and from spectroscopic observation (by the method almost simultaneously carried out by Janssen and Lockyer a good many years ago, and pointed out by the latter as feasible some time previously), are proved to exist almost without interruption. This failure is due to the fact that the light of the sun's surface is usually so immensely brighter than the prominence light that the two cannot be impressed at the same time. A prominence, as a rule, emits light, which, when analyzed by the spectroscope, gives a few —very few—bright lines, while the sun's surface gives what we may for our purpose consider a continuous spectrum, though of course it is seamed with the almost innumerable fine dark Frauenhofer lines, the number increasing as the spectrum is increased in length and purity. A solar prominence, however, is not superior in brightness, speaking approximately, to the solar surface, if only the rays which are common to both are considered. Hence, if we could photograph an image of the sun with monochromatic light of the kind emitted by the prominence, we might be able to get an image of the surface surrounding the prominences. We should have a further help in doing this, from the fact that the bright lines in the spectrum of the prominences are represented by dark lines in the spectrum of the surface. They are not black lines devoid of any light, but dark in comparison with the adjacent bright parts of the spectrum. Hale, of America, and Deslandres, of Paris, have both obtained images of the sun in monochromatic light by the artifice of throwing an image of the sun on the slit of the spectroscope. A section of the sun's image is spread out into a spectrum, and by placing a slit in the color which they wished to use, and allowing only the light coming through it to fall on a photographic plate, the intensity of the light at various parts of this section is recorded. When the image of the sun is caused to travel over the slit, this one part of the spectrum, but of a different section of the disk, is presented to the photographic plate at each instant, and if the plate be moved across the slit in the spectrum, these successive images will be separately impressed, joining one another till the whole surface is impressed on different portions of the plate by the rays of one color. Some excellent results have been obtained by both these men of science by this artifice, and very interesting they are. So far, the light that they have principally employed is the light of the H or K line in the extreme violet end of the spectrum. The mottling of the sun's surface is shown very much more prominently than when a photograph is taken in the ordinary way, what are known as the faculæ being seen very beautifully, as they emit more of this light than of that of any other color. The success of this plan of obtaining a monochromatic image is largely dependent on the equable and smooth movement of the plate across the slit in the spectrum, and the size of the image is



O, FIG. 4.



P, FIG. 3.

naturally limited by the apparatus that has to be employed. It seemed to the writer that if a monochromatic image, as a whole, could be obtained at one time, the ease with which a photograph could be obtained would be considerably increased. Very nearly eleven years ago he indicated the possibility of this when he brought forward his apparatus for producing a monochromatic patch of light. He stated that a monochromatic image of the sun could also be produced on a screen, and, therefore, on a photographic plate. Lord Rayleigh described about the same time a telescope for viewing with the eye a source of light monochromatically. It does not appear that this method of getting a monochromatic image on a plate has been tried, or at all events there is no record that it has been, and, as an outcome of another investigation, the writer recently showed at the Royal Society the means by which this could be accomplished. The apparatus to produce a patch of monochromatic light is very simple. In its crudest form it requires a source of light such as the sun or the electric arc light, a slit on which an image of the source is thrown, a collimating lens at the end of the tube to which the slit is attached to render the rays parallel on egress, a prism placed in the path of the rays, and a lens in a camera, to form an image of the slit, and thus to give a spectrum. If a second slit be placed in the spectrum, any color can be isolated, and a lens of proper focus placed near this slit will cast an image of the illuminated face of the prism on a screen.

If we place a stencil plate against the first surface of the prism, we should get an image of the stencil plate, or if we could cast an image of the points of the electric light on the prism, we should equally get an image of them on the screen in the monochromatic light which is passing through the slit in the spectrum. The point is, How are we to cast an image of the points on the prism? It is not a difficult matter. Suppose we place a lens of about half the focal length of the collimating lens close to the slit, we can move the electric light to such a distance that an image of the points will be cast sharply on the prism, the slice of lens covering the slit acting as if the whole of the lens were employed. By this simple artifice the problem is solved. When no slit is placed in the spectrum the lens behind it collects the whole of the colors and recombines them into a brilliant white image of the points. We can then pass the slit along the spectrum, only allowing one color at a time to pass through to the lens, when we shall have a succession of images of the points in different colors. Volatilizing, say, a little lithium and sodium between the poles of the electric light, we shall see, when the slit arrives at those parts of the spectrum where the bright lines which these vapors emit are situated, the interval between the points filled with a brush-like flame, but when the slit passes beyond these parts the intervals between the points will be blank or nearly so. But we can further increase the utility of this method, for we can place any practicable number of slits in the spectrum, and provide each with separate strips of lenses of equal focal length, and so arranged that they will place a number of monochromatic images side by side on the screen. We can replace the screen by a photographic plate, and can thus obtain (by using proper precautions as to exposure) a number of images on the same plate showing any variations which may exist, due to the different parts of the spectrum. Now what applies to the electric light applies to the sun. An ordinary collimator rarely exceeds three feet three inches in length, and is often only one-third of that length. As, practically speaking, every foot in the focal length of a lens gives a diameter to the image of the sun of one-tenth of an inch, it follows that the size of the image that could be cast on the prism through an ordinary collimator would rarely be more than one third of an inch in diameter. Though such an image can be enlarged up by the other apparatus employed for producing the monochromatic image, an enlargement to three or four inches would be too great a strain on the optical arrangements. The way out of the difficulty is to use a long telescope, say ten feet long, as a collimator, which means simply reversing the tube as ordinarily used, and placing a slit where the eyepiece is usually located. If a spectacle lens of about the same focal length as the object glass be in contact with the slit, this will complete the collimator, and we should then obtain on the prism a solar image some one inch in diameter. The breadth of the spectrum would not be increased, since it would be the image of the slit; while a proper choice of the focal length of the lens behind the slit in the spectrum would enable the image to be magnified up to the desired diameter. There is always a certain degree of diffraction taking place by the passage of the light through both slits, and for solar work the wider the slit (within limits, of course), the better the definition will be. If such a long collimator as that suggested be employed, the slit may be opened ten times the width that it can be if it were but one foot long, without impairing the purity of the spectrum, hence for this work the long collimator is a desideratum.

Now, so far, we have confined ourselves to supposing we are to use only one prism, but two or more may be employed, so as to get better dispersion (i. e., length of spectrum), and therefore of purity. But we are not confined to prisms for the production of the spectrum. We can use diffraction gratings when the number of ruled lines per inch is large, and we get with the least possible trouble a spectrum equal to several prisms. Such is a brief outline of a plan for obtaining monochromatic images. Images of transparent objects, such as of a fly's wing, have been photographed when illuminated by various colors, to test the definition obtainable, and they appear to those who have seen them that they are only slightly, if at all, inferior to photographs obtained by ordinary methods. Whether there are objections to the plan proposed which the writer has not foreseen must be tested by experience. The plan is so simple that it should at all events be given a fair trial.—Photography.

THE largest mirror ever brought to America has been placed in the dining room in the new wing of the Hotel Savoy, in New York. It occupies about the entire end of the room and gives the impression that it is a big arch leading to a large apartment. The plate is 12 ft. high and 13½ ft. long, and the package which contained it was a foot larger each way. Several attempts to produce a flawless glass of the size were made before the manufacturers were satisfied. This glass was made by the factory at St. Gobain, which is the oldest and largest factory in Europe. The frame looks like malachite and is lined with gilt.

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